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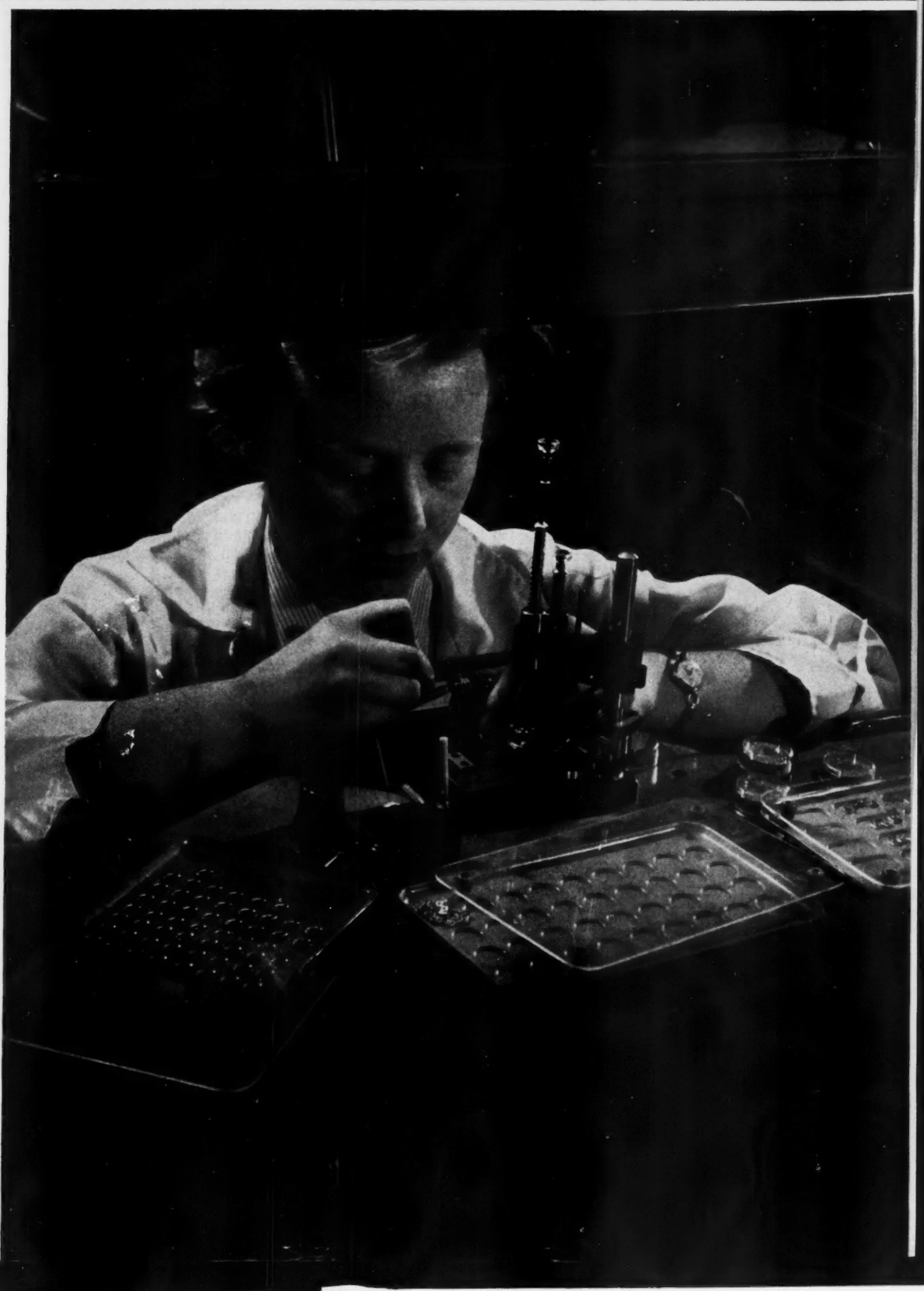

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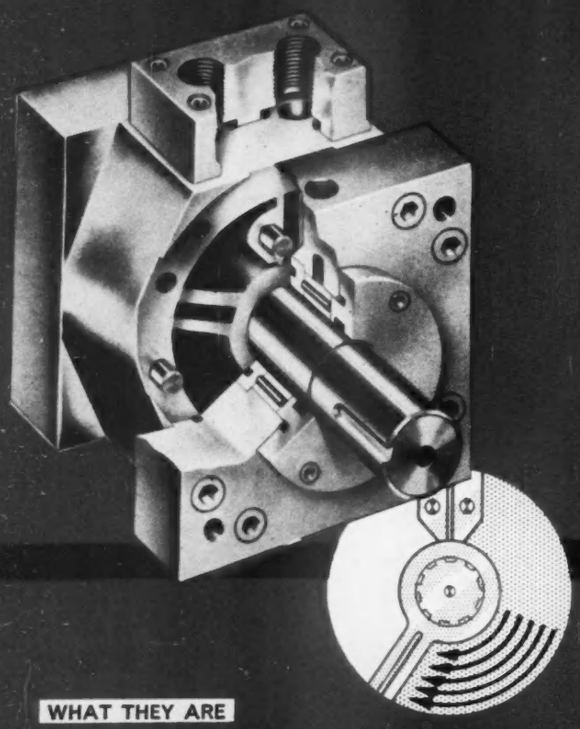

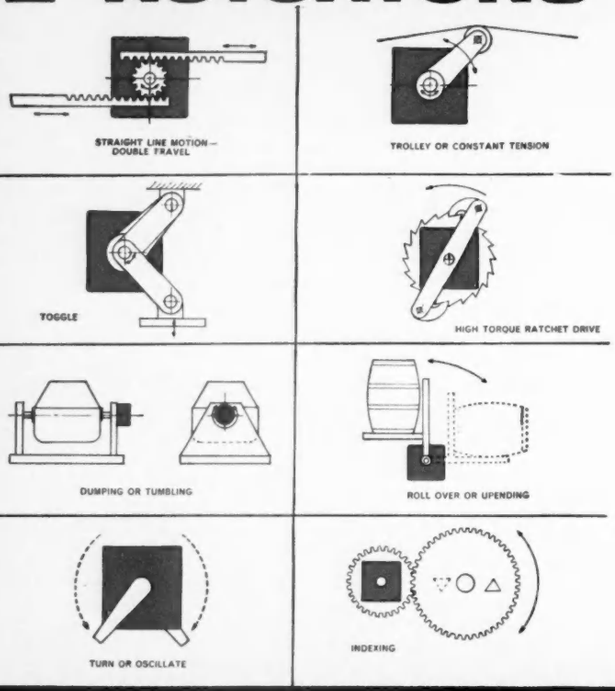

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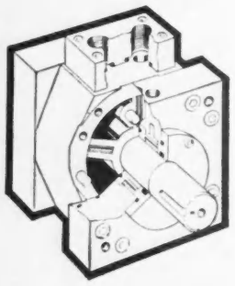

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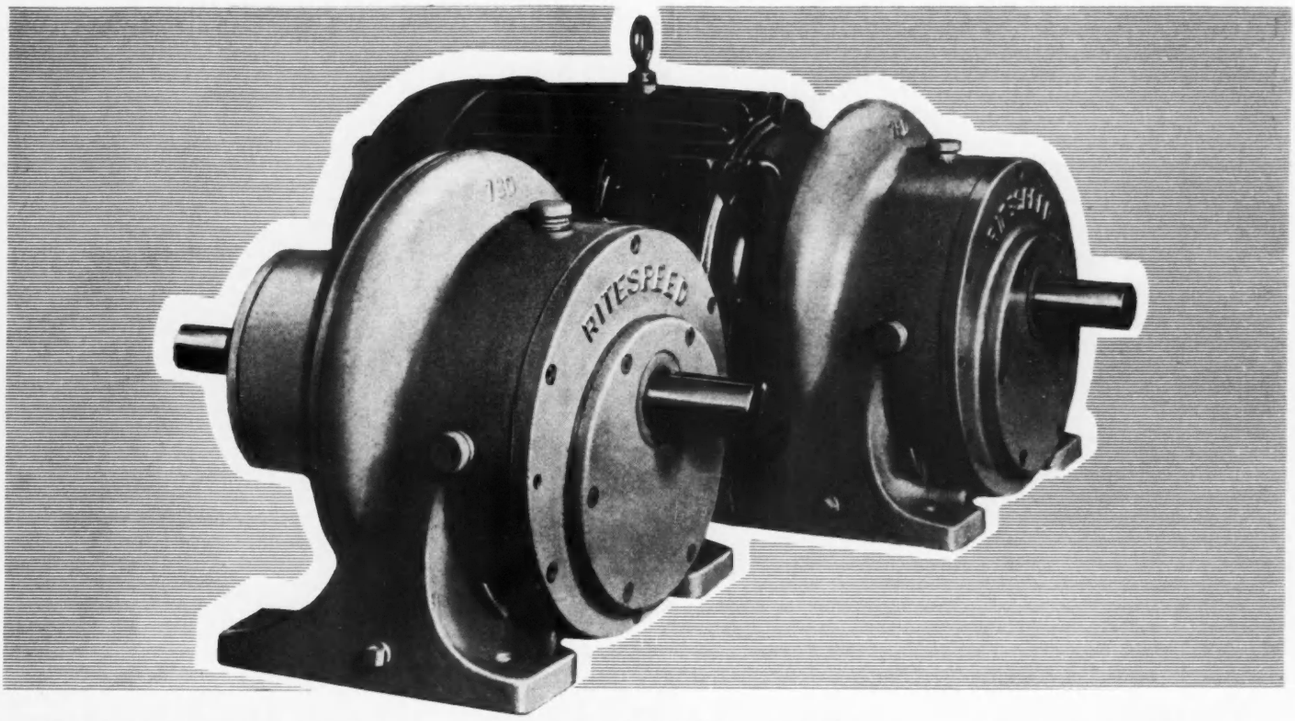

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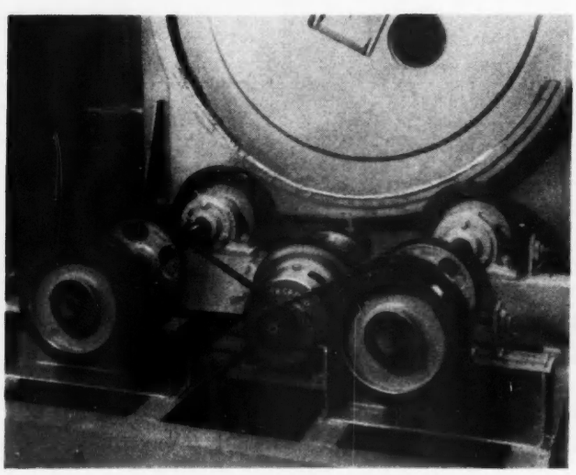

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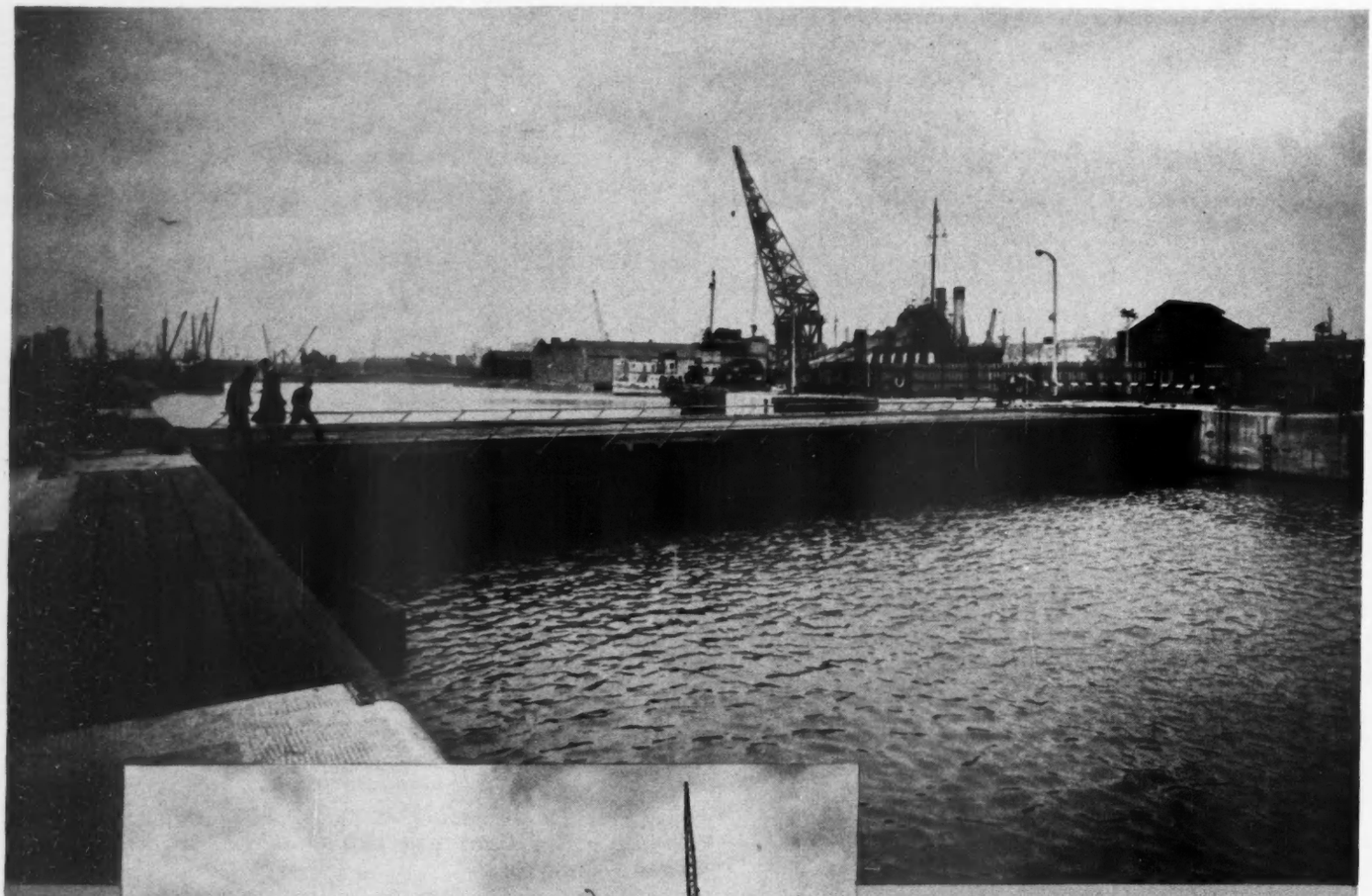

Caissons at Liverpool

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Assembling the balance and spring of a watch. The operation is done in two parts: first the assembly of the balance and spring on to the bridge, and then the fitting of the bridge into the watch. (*Nurnberg photograph for* ENGINEERING.)

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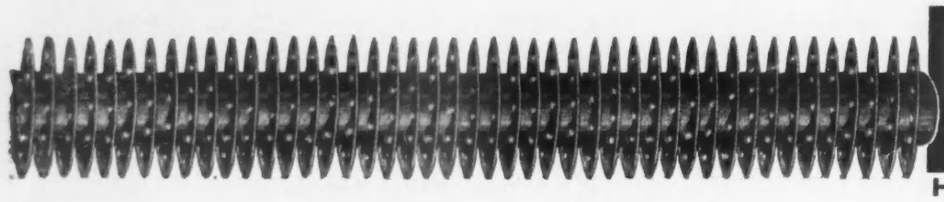

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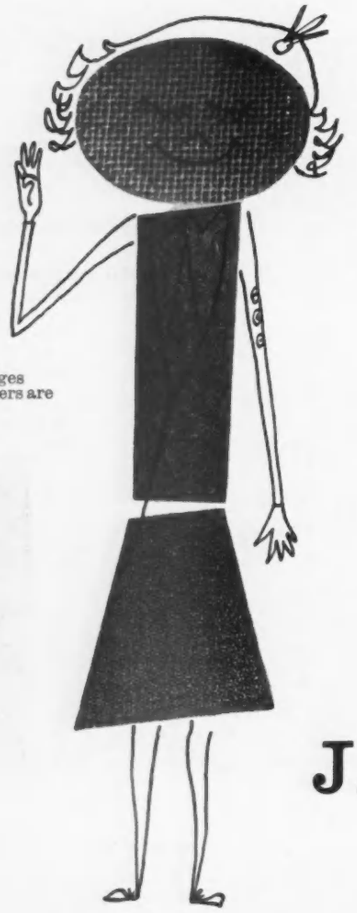

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"For the supply of one overhead electric travelling Crane of 100/20 tons capacity. Span 75 ft. approx. required by the Madya Pradesh State Electricity Board, for Amarkantak Thermal Power Station."

Specifications, etc., relative to the above specification, can be obtained from the CO-ORDINATION BRANCH, INDIA STORE DEPARTMENT, BROMYARD AVENUE, ACTON, W.3, at a cost of £1 1s. 5d. per tender, and is not refundable. Tenders are to be returned direct to INDIA SUPPLY MISSION, 2536, MASSACHUSETTS AVENUE, N.W. WASHINGTON S, D.C., UNITED STATES OF AMERICA, so as to reach them by 5th April, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, W.3, under the following reference: S.3964/59/NSC/ENG.2. B 309

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, W.3, invites
TENDERS for the supply of:—
TENDER REF. NO. I8155/59/BMB/HAL
"800 sets of Solid Rolled or Forged Steel Carriage Wheels to I.R.S. drawings and 400 sets of Rough Machined Steel Axles for Rail Carriages."

The Tender forms with Schedules and Specifications which are returnable on 10.3.1960, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for tenders should specify the above reference. B 307

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, W.3, invites
TENDERS for the supply of:—
TENDER REF. NO. I8151/59/BMB/HAL
"3200 off" Rubber-Metal "Flexible mountings of various sizes for Railway Bogies."

The Tender forms with Schedules and Specifications, which are returnable on 10.3.60, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each tender.

Applications for tenders should specify the above reference. B 306

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, W.3, invites
TENDERS for the supply of:—
TENDER REF. NO. I8149/BMB/HAL
"Bolster Springs—Outer and Inner for Railway Bogies."

The Tender forms with Schedules and Specifications, which are returnable on 10.3.60, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each tender.

Applications for tenders should specify the above reference. B 305

HINDUSTAN CHEMICALS & FERTILIZERS, LTD.
TROMBAY FERTILIZER FACTORY PROJECT—EXTENSION OF DUE DATE

With reference to the Enquiry which appeared in the Press on 4.9.59 calling for tenders for the above Project, the due date for parts (3) and (4) of this Project (i.e. Nitric Acid Plant and Nitro-phosphate Plant has been extended from 29th February, 1960, to 30th June, 1960.

Parts (1) and (2) must still be submitted by 29th February, 1960. Ref. 8 3434/59/NSC/ENG.2. B 318

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, BROMYARD AVENUE, ACTON, W.3, invites
TENDERS for the supply of:—
TENDER REF. NO. I8150/59/BMB/HAL
"Rubber Bonded Metal Buffers and Stops; and Axle Holding Rubber Linings."

The Tender Forms with Schedules and Specifications, which are returnable on 10.3.1960, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for tenders should specify the above reference. B 308

FRASERBURGH HARBOUR
OPENING BRIDGES

The Fraserburgh Harbour Commissioners will shortly be inviting **TENDERS** for the **FABRICATION AND ERECTION OF TWO OPENING BRIDGES** in connection with their proposed improvements at Faithlie Basin. The bridges will be of the traversing type. One bridge, for vehicles, will be electrically operated and will span a 40 ft. clear opening. The other will be a hand operated footbridge spanning a 27 ft. skew opening.

Experienced firms desiring to tender are asked to apply before 19th February, 1960, to the HARBOUR COMMISSIONERS' CONSULTING ENGINEERS, MESSRS. LEITCH & SHARPE, 65, BATH STREET, GLASGOW, C.2, from whom further details may be obtained.

The Harbour Commissioners do not bind themselves to accept the lowest or any tender.

ROBERT SCOTT,
CLERK TO THE HARBOUR COMMISSIONERS. B 297

FRASERBURGH HARBOUR
8 TON SCOTCH DERRICK CRANE

The Fraserburgh Harbour Commissioners will shortly be inviting **TENDERS** for the **MANUFACTURE AND ERECTION OF AN 8 TON SCOTCH DERRICK CRANE** in connection with their improvements at Faithlie Basin.

Experienced firms desiring to tender are asked to apply before 19th February, 1960, to the HARBOUR COMMISSIONERS' CONSULTING ENGINEERS, MESSRS. LEITCH & SHARPE, 65, BATH STREET, GLASGOW, C.2, from whom further details may be obtained.

The Harbour Commissioners do not bind themselves to accept the lowest or any tender.

ROBERT SCOTT,
CLERK TO THE HARBOUR COMMISSIONERS. B 298

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LATTICE STEEL ERECTION MASTS (light and heavy), 30 ft. to 150 ft. high, for immediate hire.—BELLMAN'S, 21, HOBART HOUSE, GROSVENOR PLACE, S.W.1. G 72

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2) **ONE PAIR—EUPLEX "WEIR" RECIPROCATING (STEAM) FEED PUMPS** for above. New 1957.
(3) **ONE—RADIOVISOR INDUSTRIAL SMOKE DENSITY INDICATOR.**
(4) **ONE—CO$_2$ RECORDER RANGE 0/20 PER CENT.**

Items 3 and 4 in one cabinet.

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SCHIESS 13 EK 105-40 in., hexagon turret head on cross rail, side head with square T.H., max. swing 54 in., speed range 9-117 r.p.m., h.p. motor 35, 1952 Machine.
FRORIEP KE10 40 in., as above, max. swing 54 in., speed range 3.6-180 r.p.m., h.p. motor 50, 1952 Machine.

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240 kVA 400/440 volts 3 phase 50 cycles 4-wire **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 300 h.p. vertical 7-cylinder engine by MIRRLEES BICKERTON & DAY, type ULB.7. Direct coupled at 600 r.p.m. to alternator by METROPOLITAN-VICKERS, with exciter. Set complete with standard ancillaries and switchgear.

234 kVA 400/440 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 269 h.p. vertical 8-cylinder engine by MIRRLEES BICKERTON & DAY, type UA.8. Direct coupled at 500 r.p.m. to alternator by METROPOLITAN-VICKERS, with exciter. Set complete with standard ancillaries and switchgear.

225 kVA 400/440 volts 3 phase 50 cycles 4-wire **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 262 h.p. vertical 5-cylinder engine by MIRRLEES BICKERTON & DAY, type TL.5. Direct coupled at 750 r.p.m. to alternator by BRUSH ELECTRICAL, with exciter. Set complete with standard ancillaries and switchgear.

180 kVA 400/440 volts 3 phase 50 cycles 4-wire **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 210 h.p. vertical 3-cylinder engine by MIRRLEES BICKERTON & DAY, type J.3. Direct coupled at 750 r.p.m. to alternator by BRUSH ELECTRICAL, with exciter. Set complete with standard ancillaries and switchgear.

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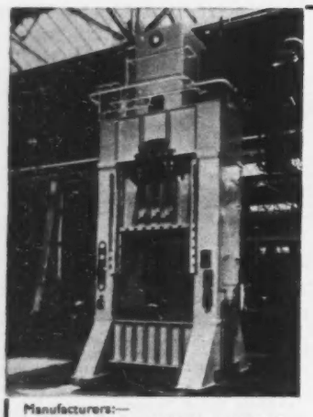

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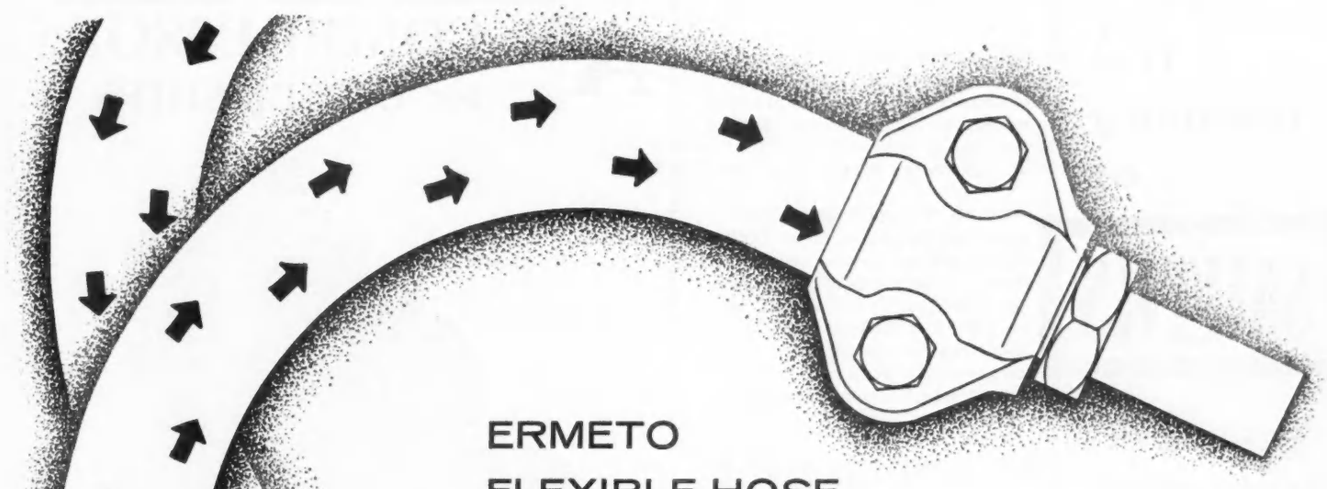

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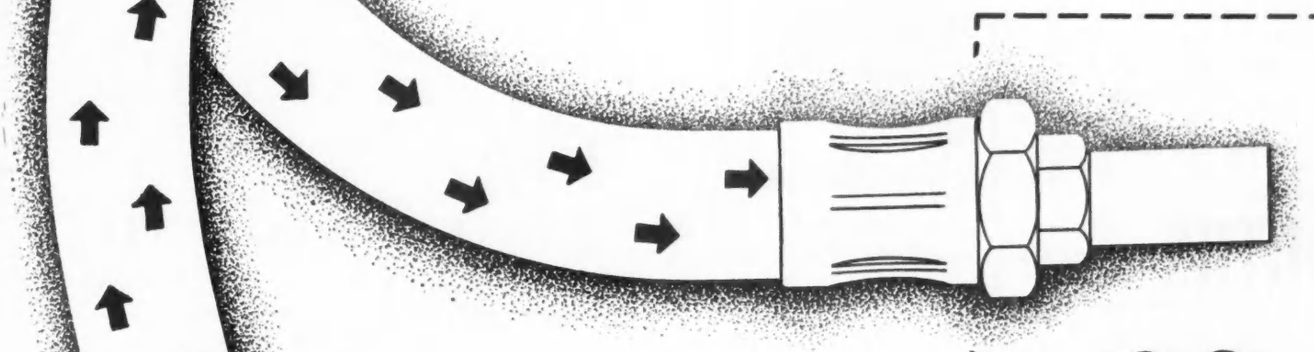

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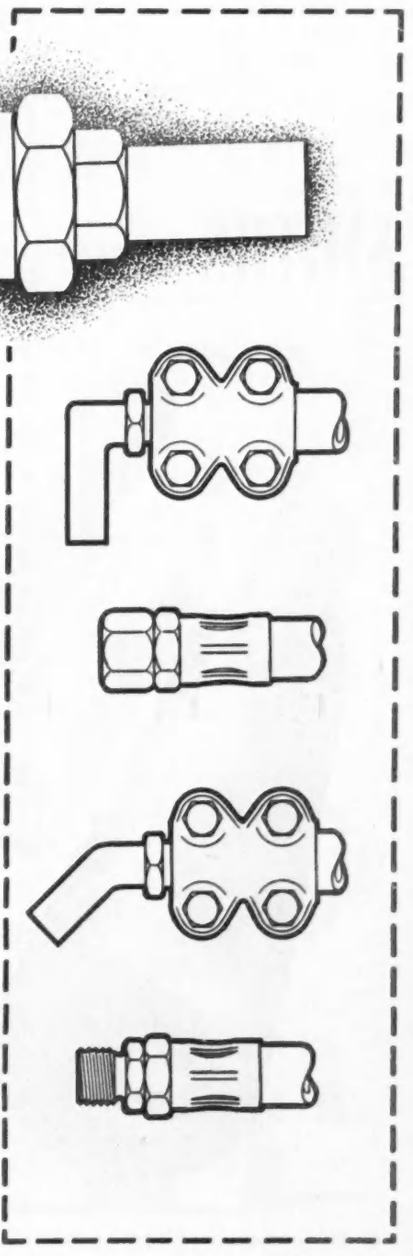

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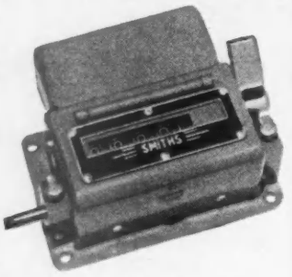

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AP/405

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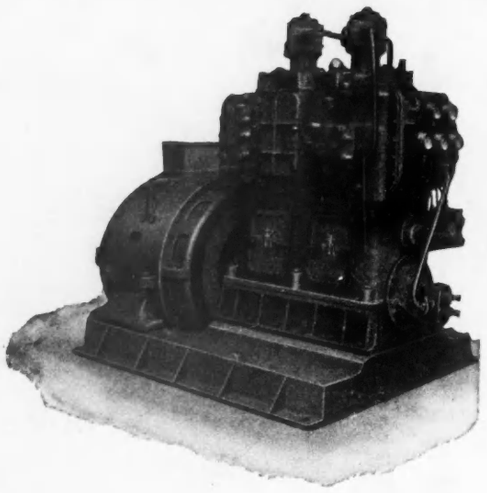

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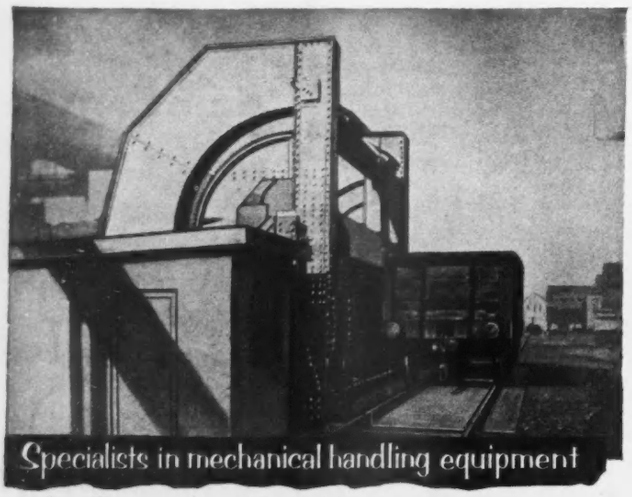

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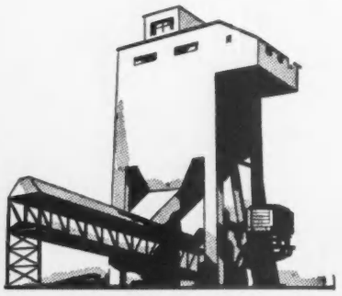

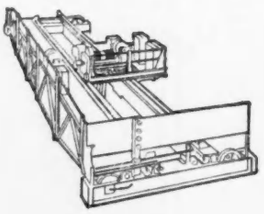

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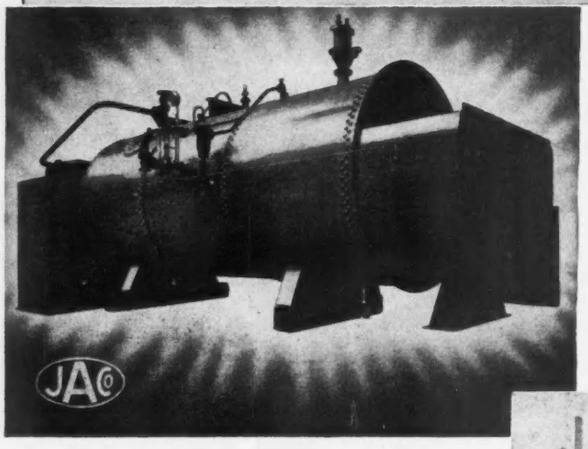
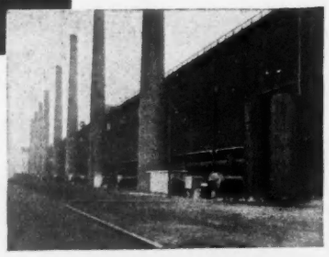
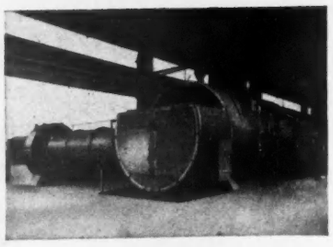
JOSEPH ADAMSON
Waste Heat Boilers



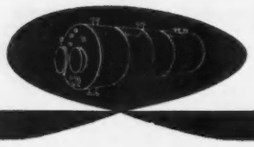




The Joseph Adamson Waste Heat Boiler is designed to make efficient use of the waste gases leaving open-hearth furnaces, reheating furnaces, soaking pits, gas retorts, etc.

The straight-through fire tubes have a high ratio of length to bore, giving about 90% tube efficiency and providing a large area of heating surface in a comparatively small space. Brickwork setting is not required and air infiltration is thus avoided.

A feature of Joseph Adamson Waste Heat Boilers is that a special cleaning device can be provided in the outlet chamber to allow the tubes to be cleaned while the boiler is at work.



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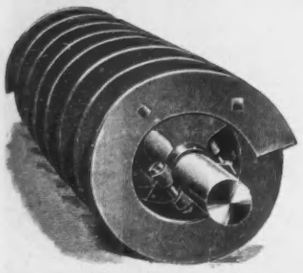

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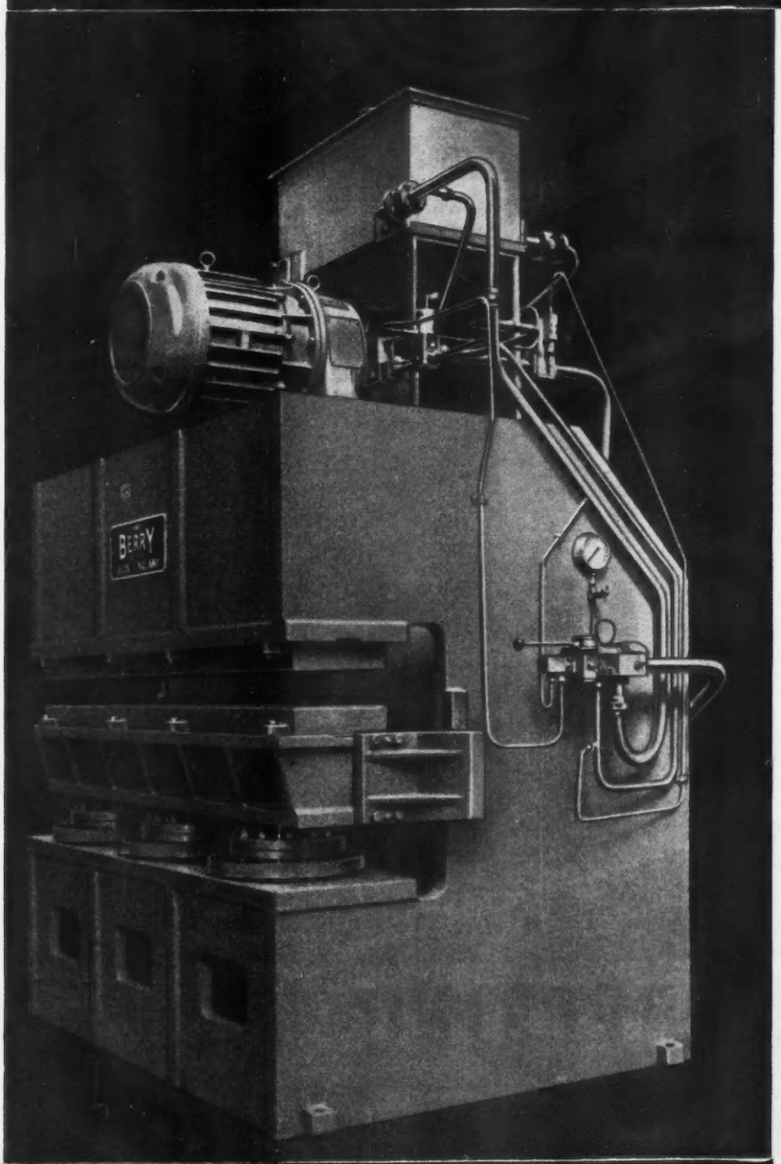

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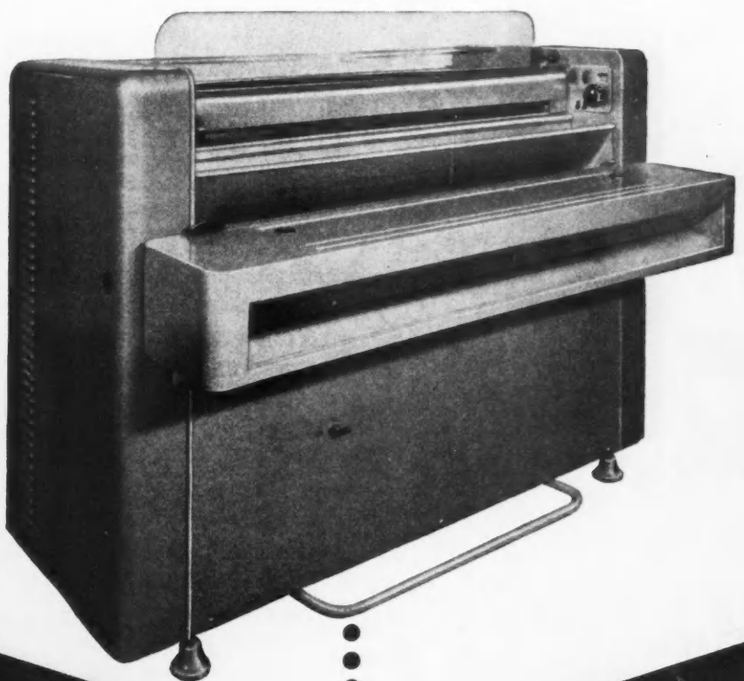

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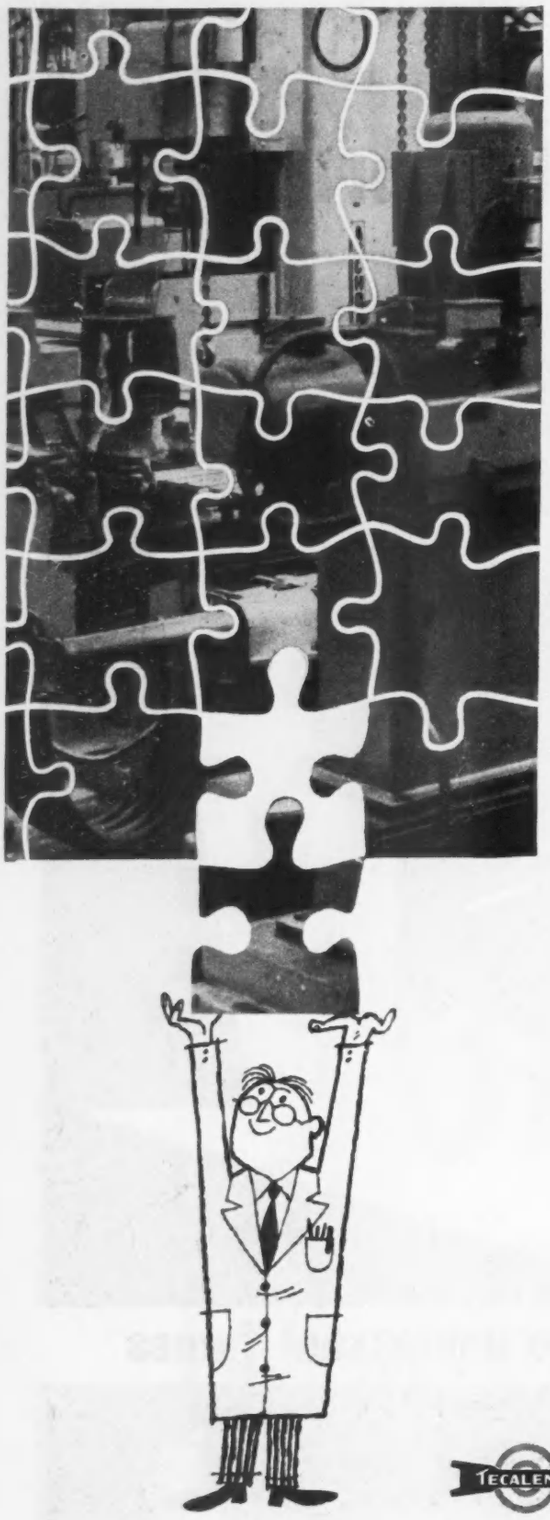

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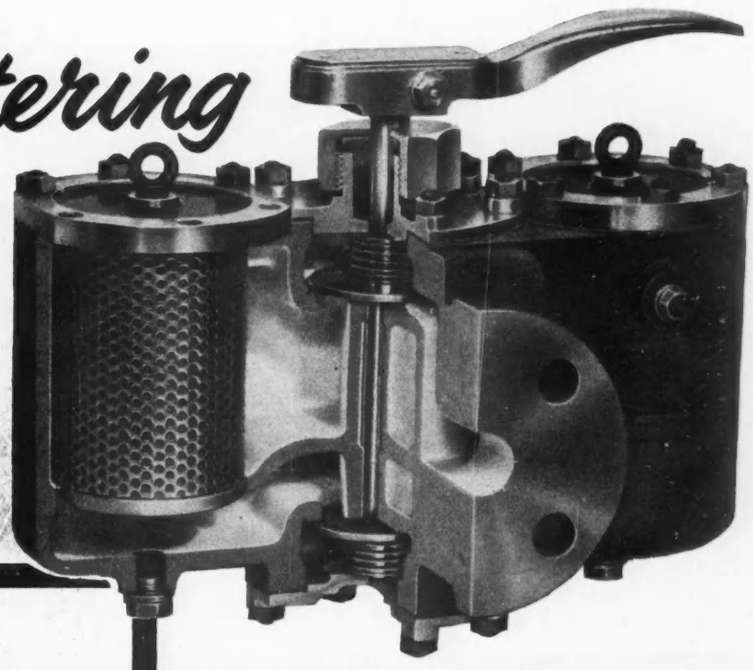

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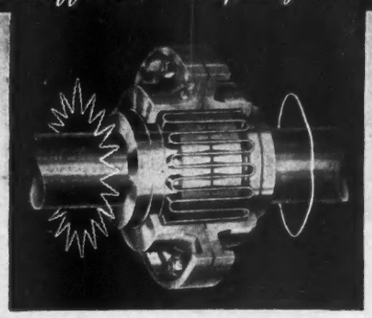

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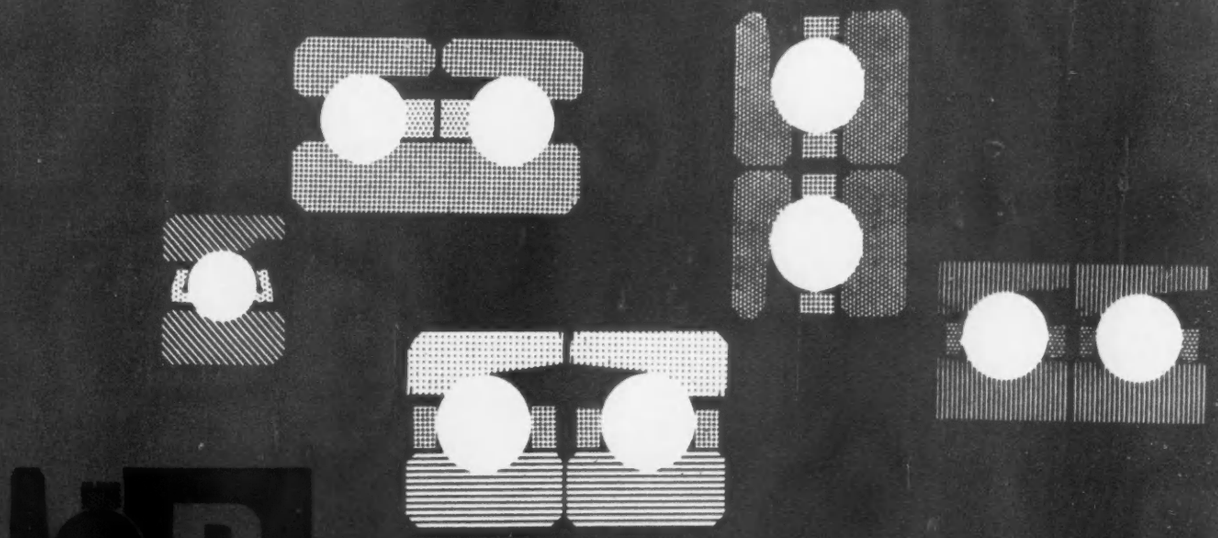

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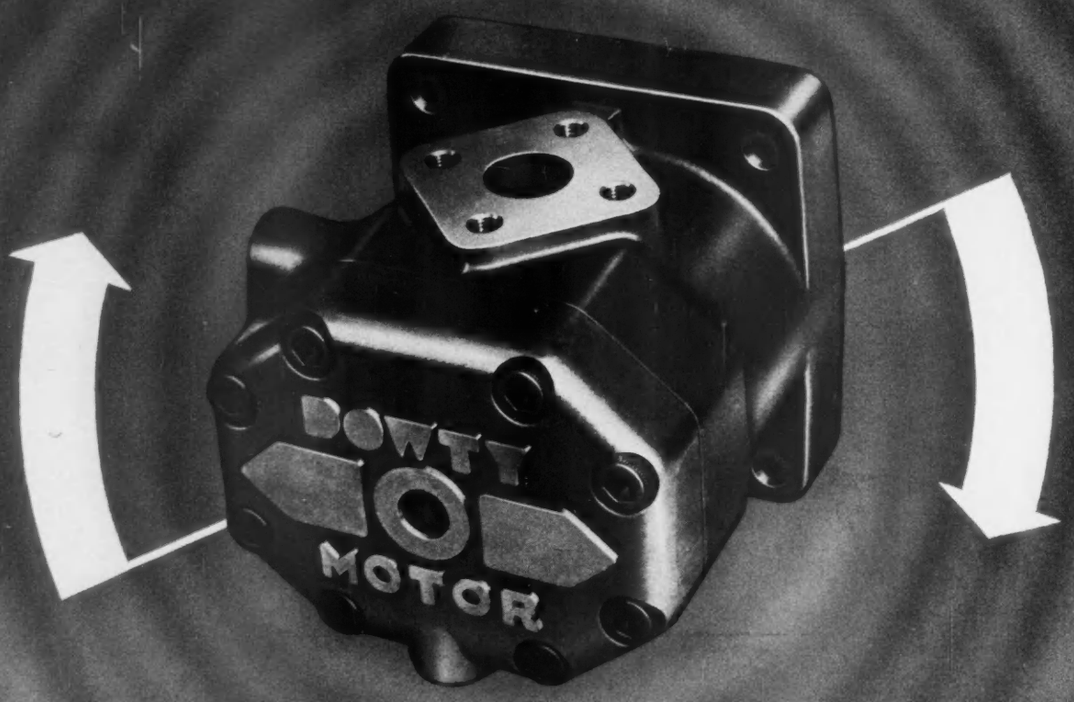

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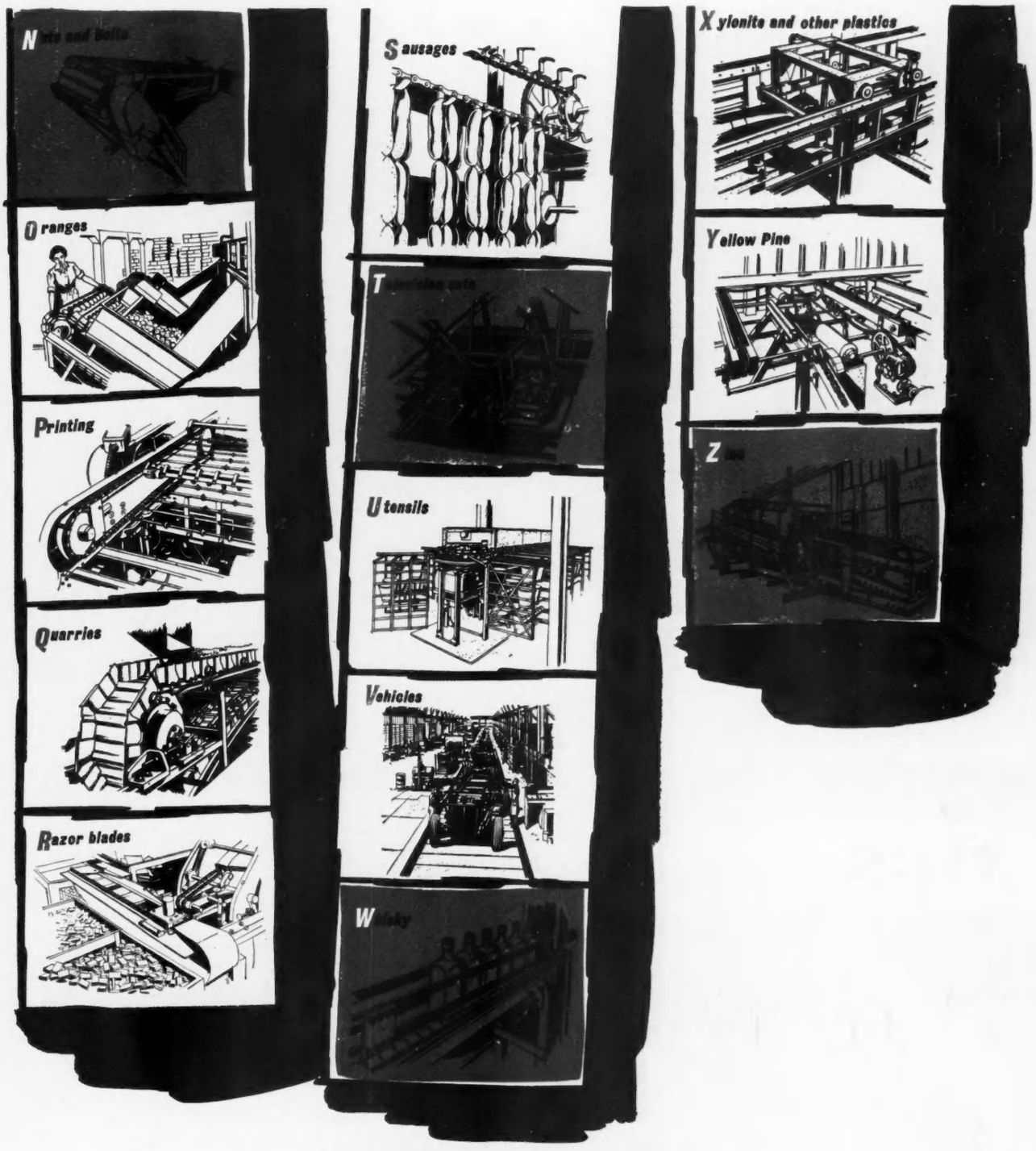

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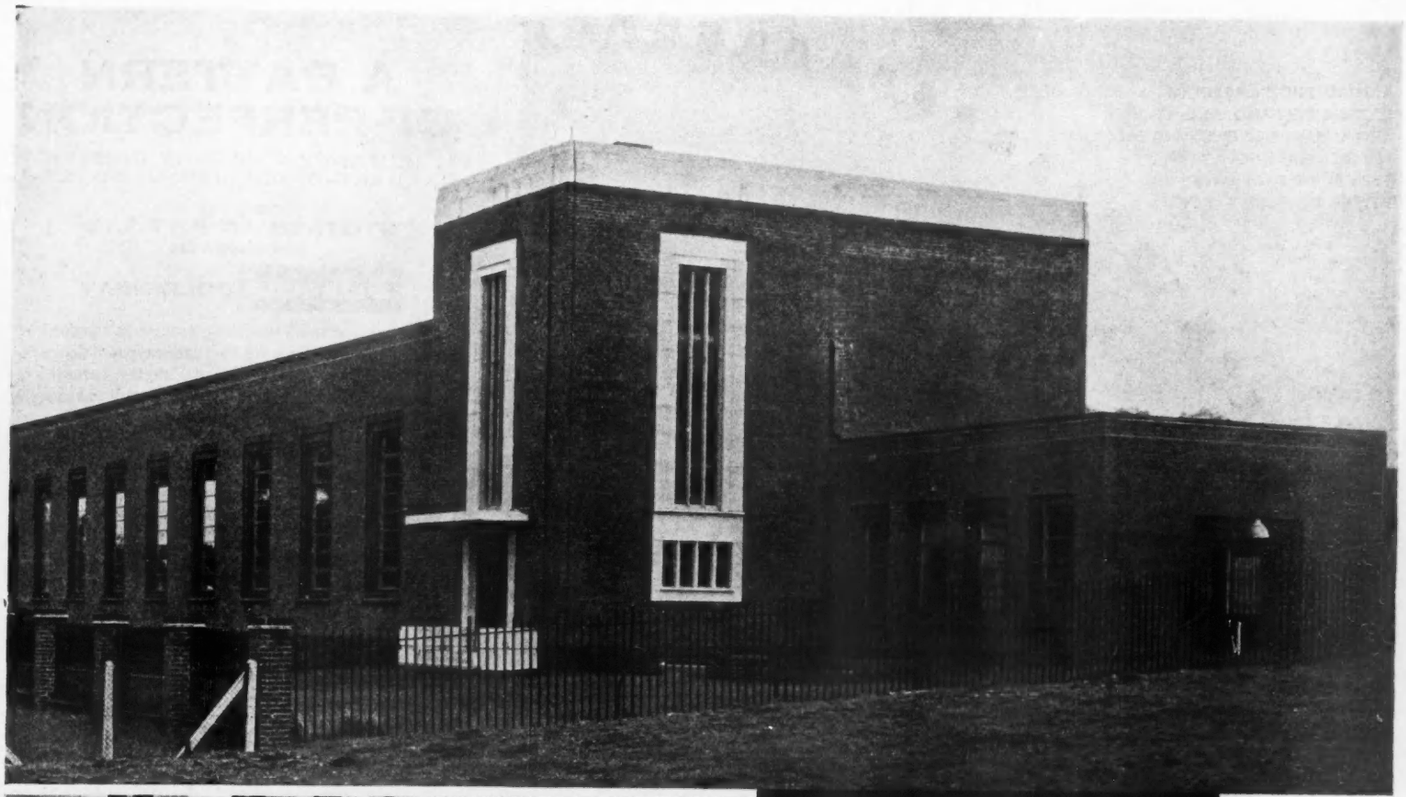

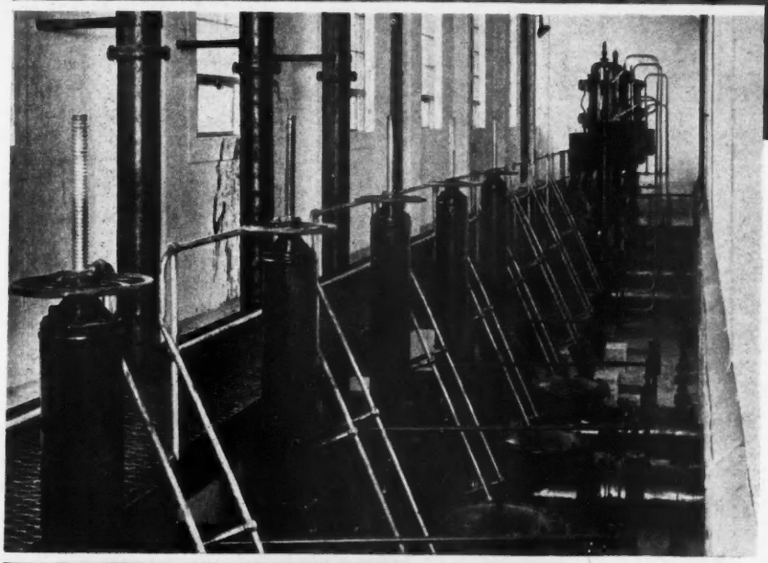

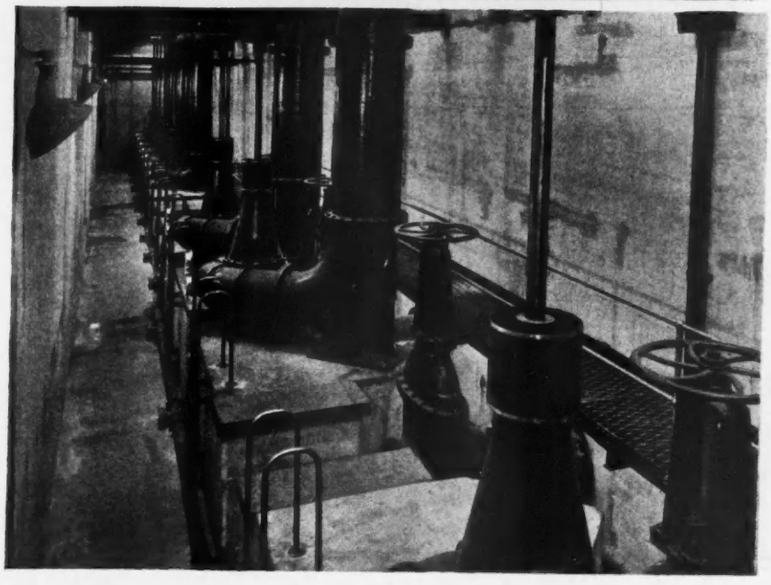

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3 Storm Pumps each capable of delivering 10,000 gallons of sewage per minute against a total head of 29 feet. Driven by 120 B.H.P. motors.

By courtesy of M. A. Kershaw, Esq., F.C.S., F.I.P.H.E., F.Inst.S.P., General Manager

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For hardening straight spur gears 1.5 to 26 in. dia., face width up to 6 in., dia. pitch 2 to 10, and helical gears of similar dimensions up to 30 deg. helix angle.

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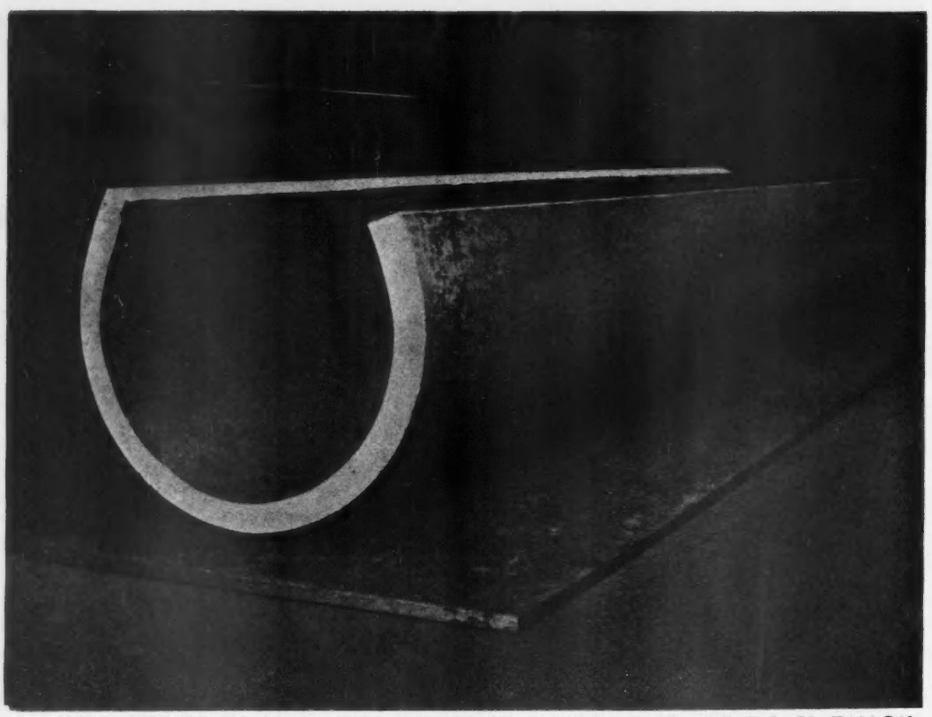

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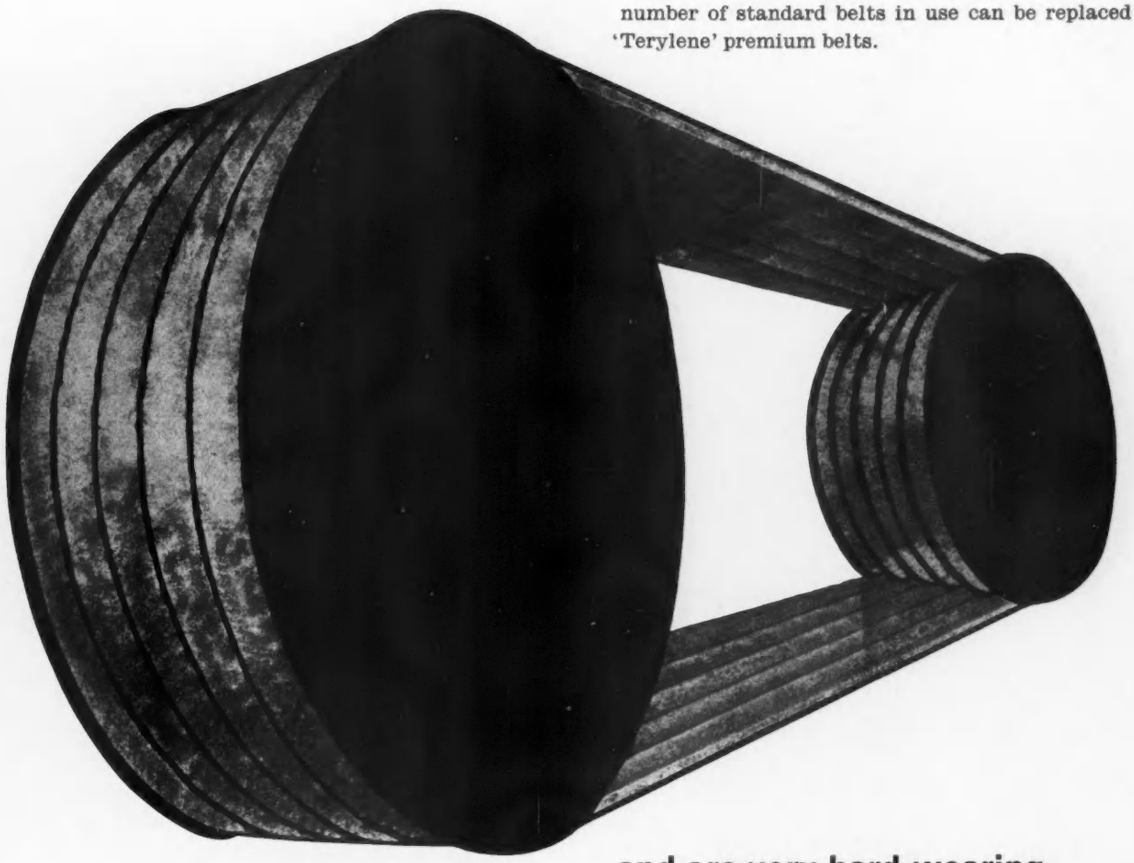

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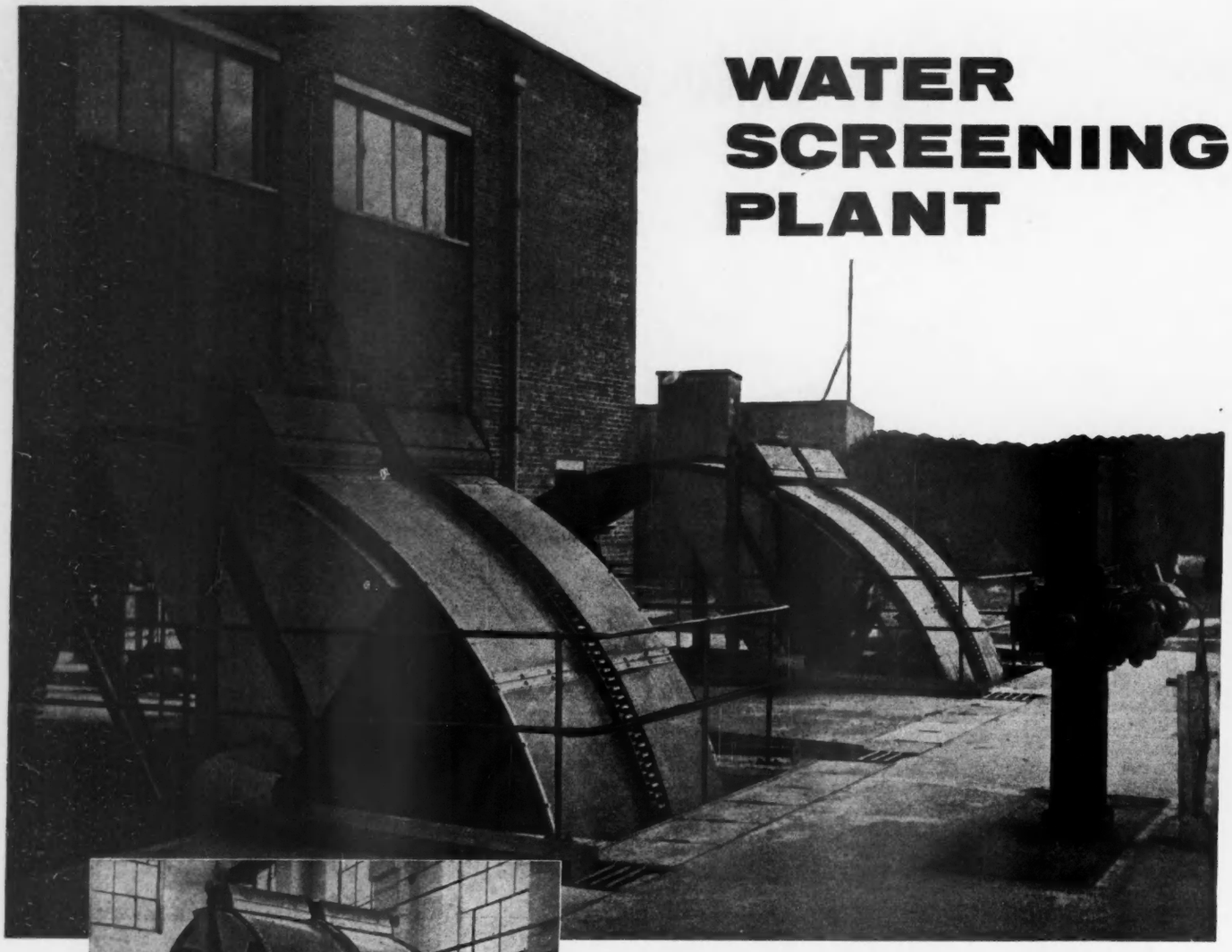

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The examples illustrated are of Revolving Drum pattern. Amongst recent orders for this type are the four 38-ft. diameter units supplied for Kincardine Power Station of the South of Scotland Electricity Board; and the six 30-ft. diameter units at present in hand for Uskmouth Power Station, of the Central Electricity Generating Board.

The headstock visible on the right of the installation view belongs to the motor operated screen chamber penstock—another notable Blakeborough speciality.

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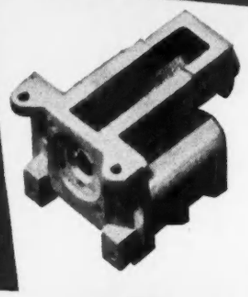

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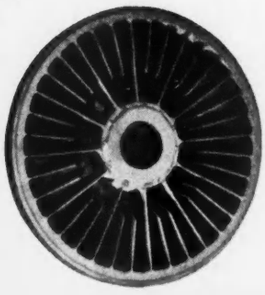
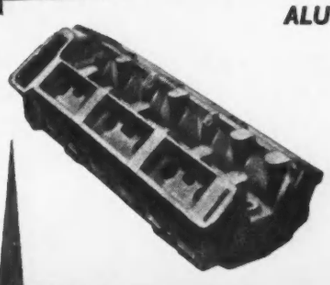


GRAVITY DIE CASTINGS

Examples of Aluminium Alloy Castings supplied on regular delivery ON TIME — Fluid Flywheel Rear Casing in L.M.23.



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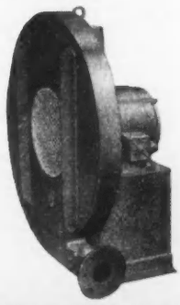

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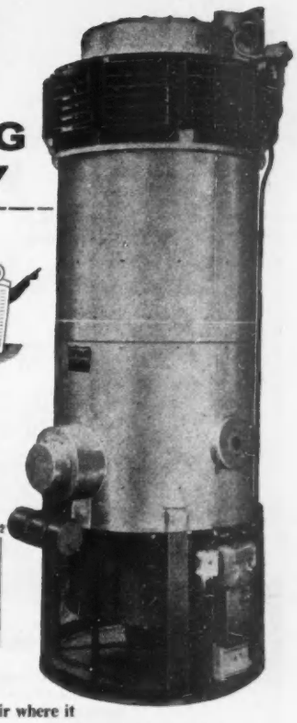

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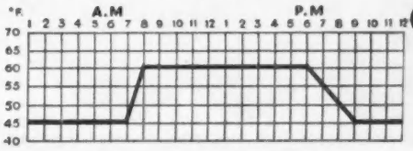

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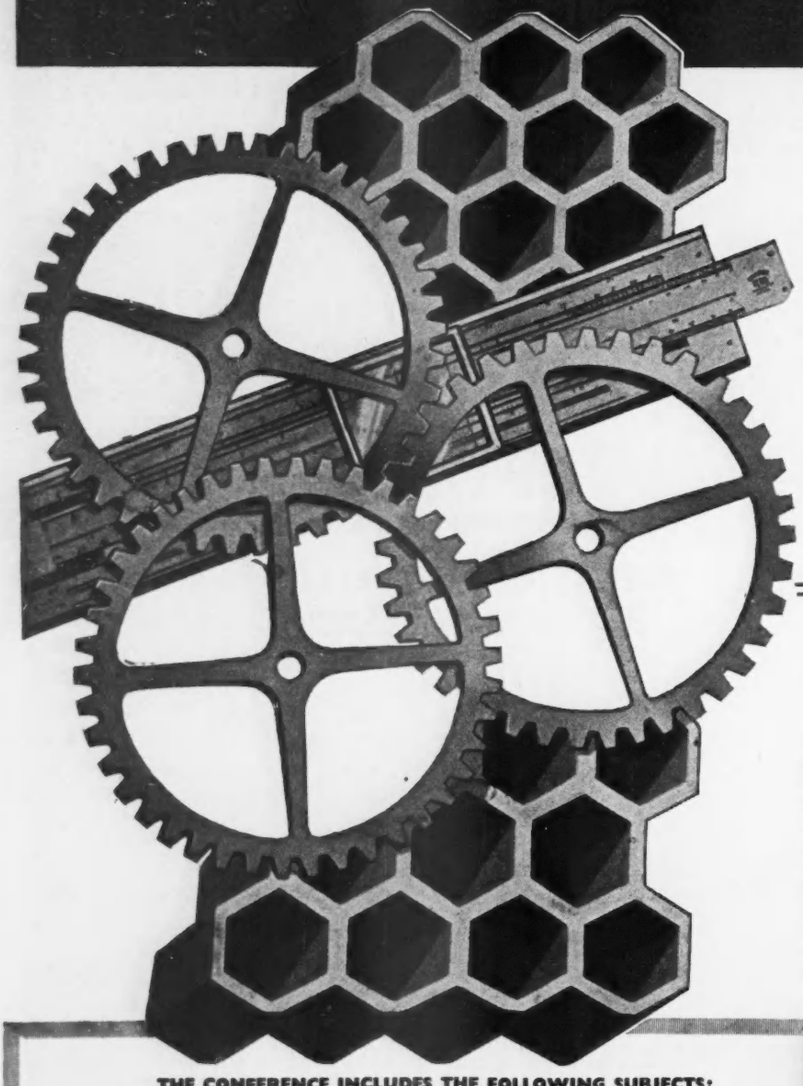

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Vacuum melted materials
Magnesium alloys
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Tuesday, February 23
Beryllium
Powder metallurgy
Reinforced plastics
Rubber in engineering
Plastics for high temperatures

Wednesday, February 24
Developments in fluid power
Centrifugal castings
Cast iron as an engineering material

Thursday, February 25
Seals
Pumps
Standards in design
Safety in design
Engineering design in Britain, Germany and Russia

Friday, February 26
The case for industrial design
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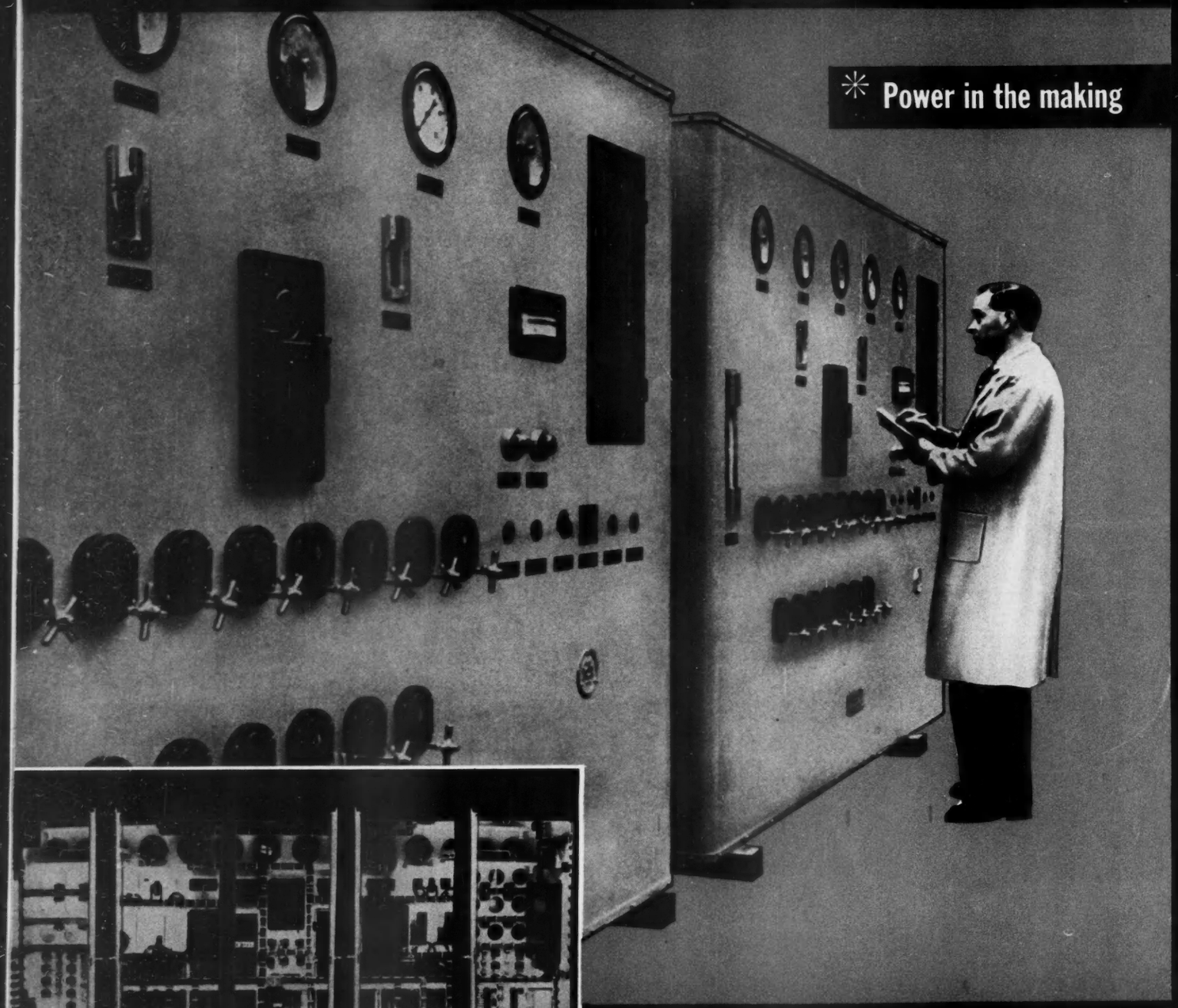
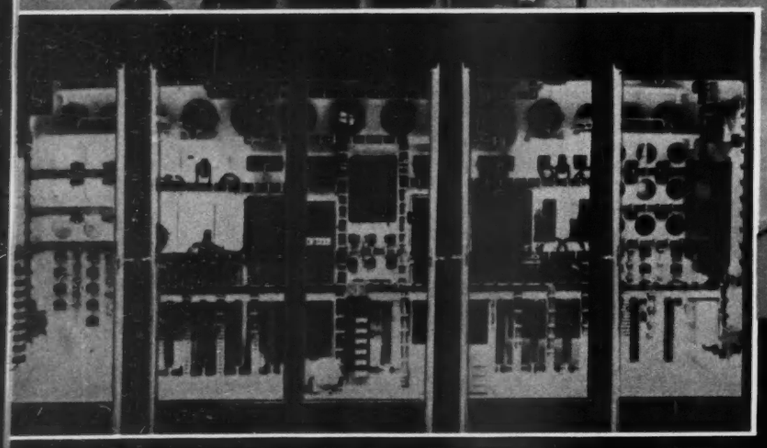


A control panel for a PARSONS hydrogen cooled generator.



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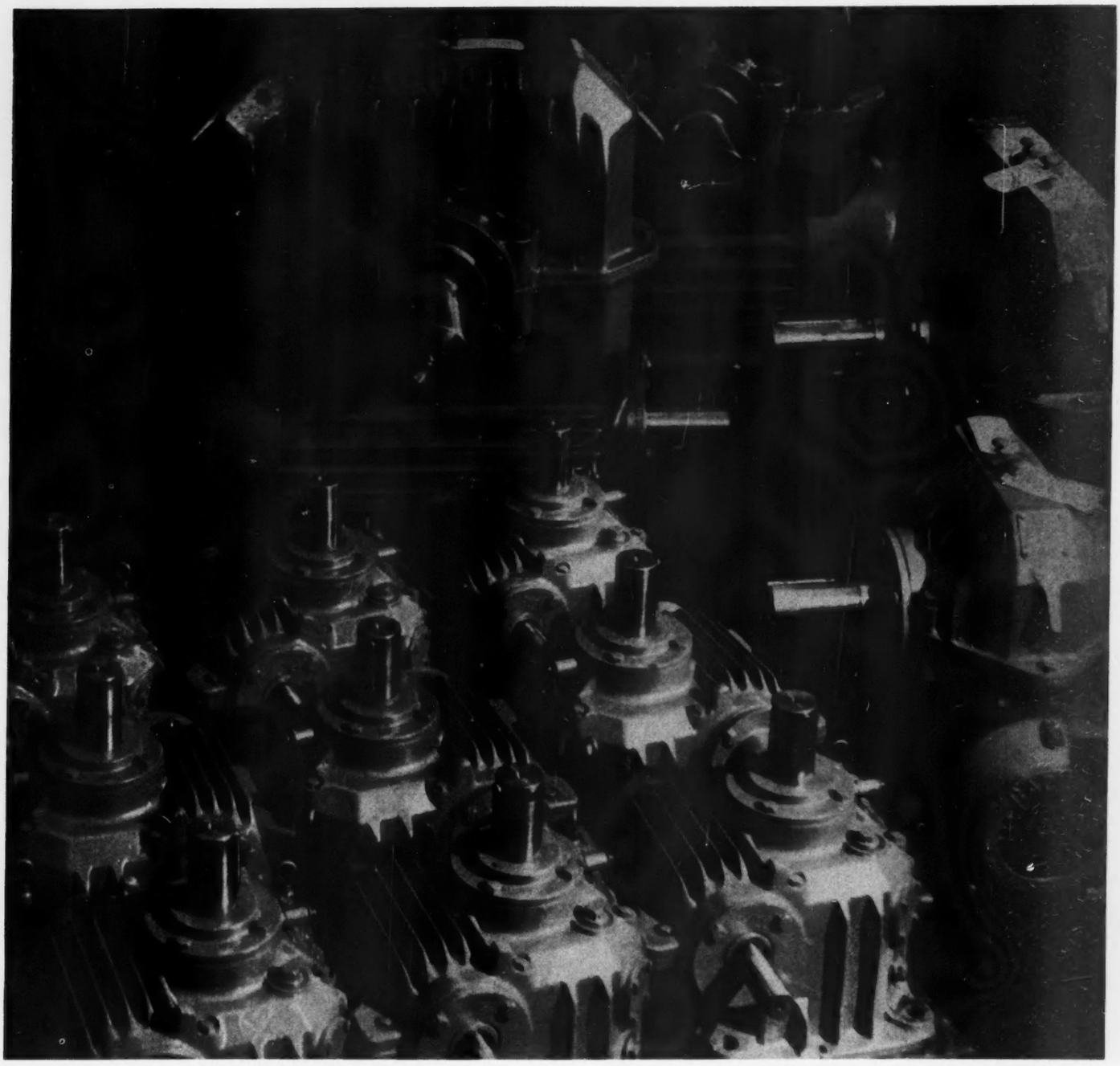

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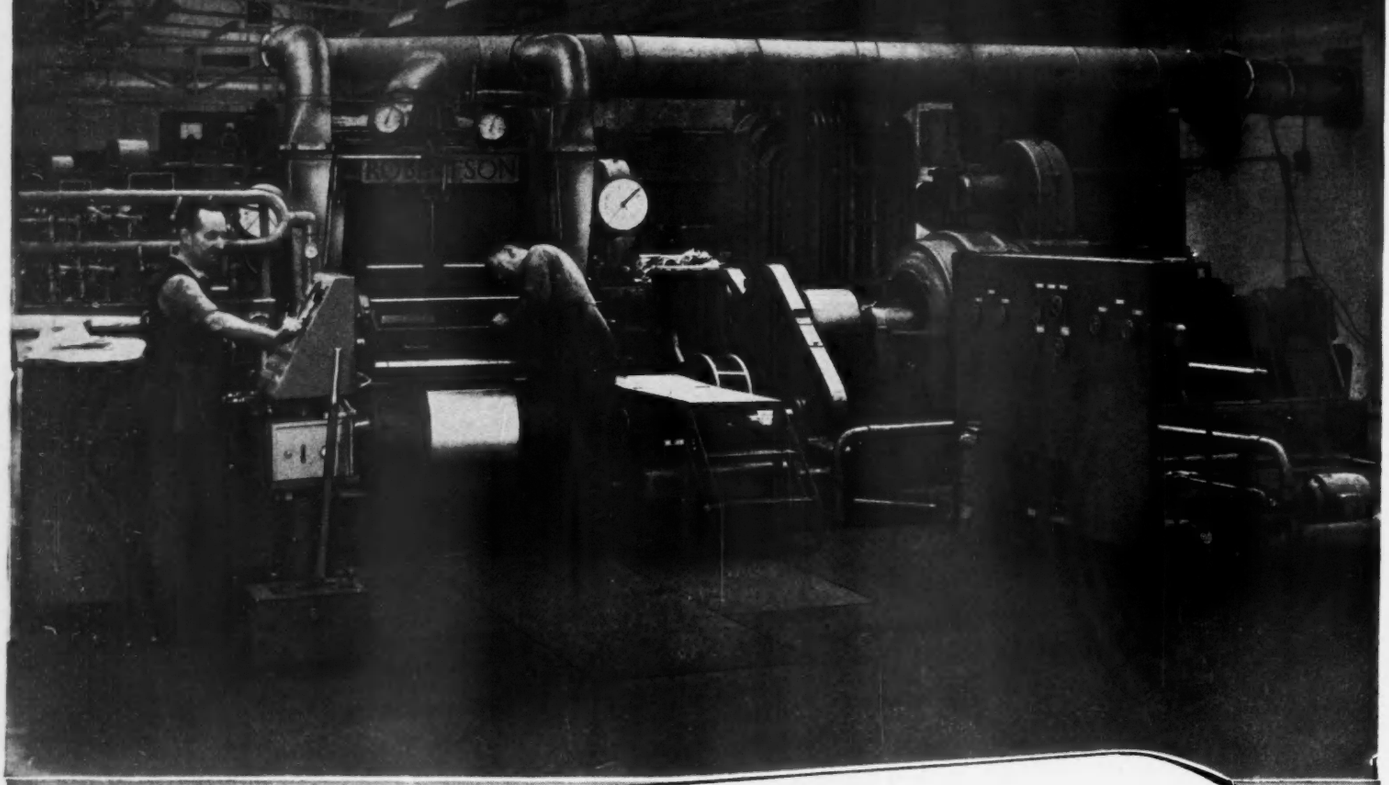

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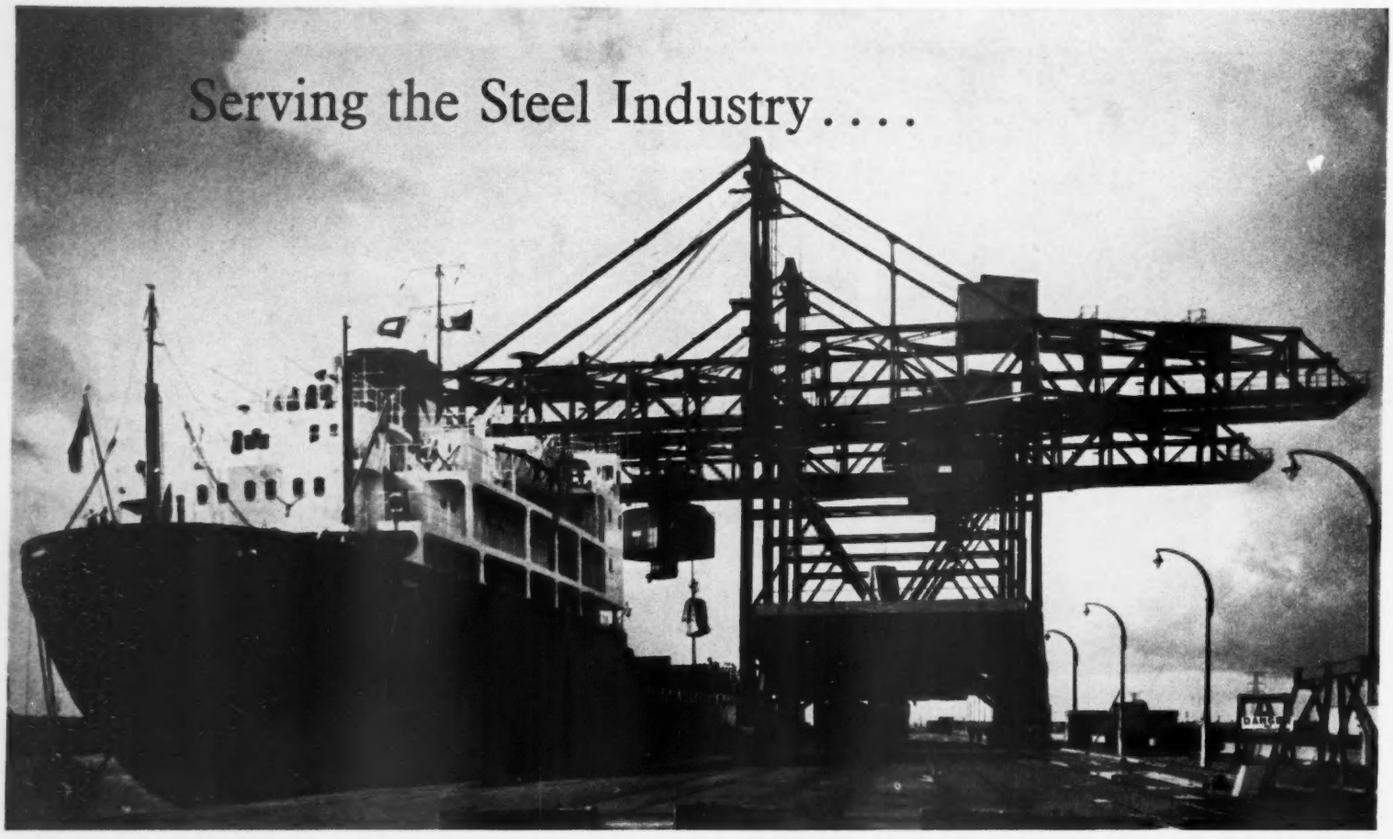

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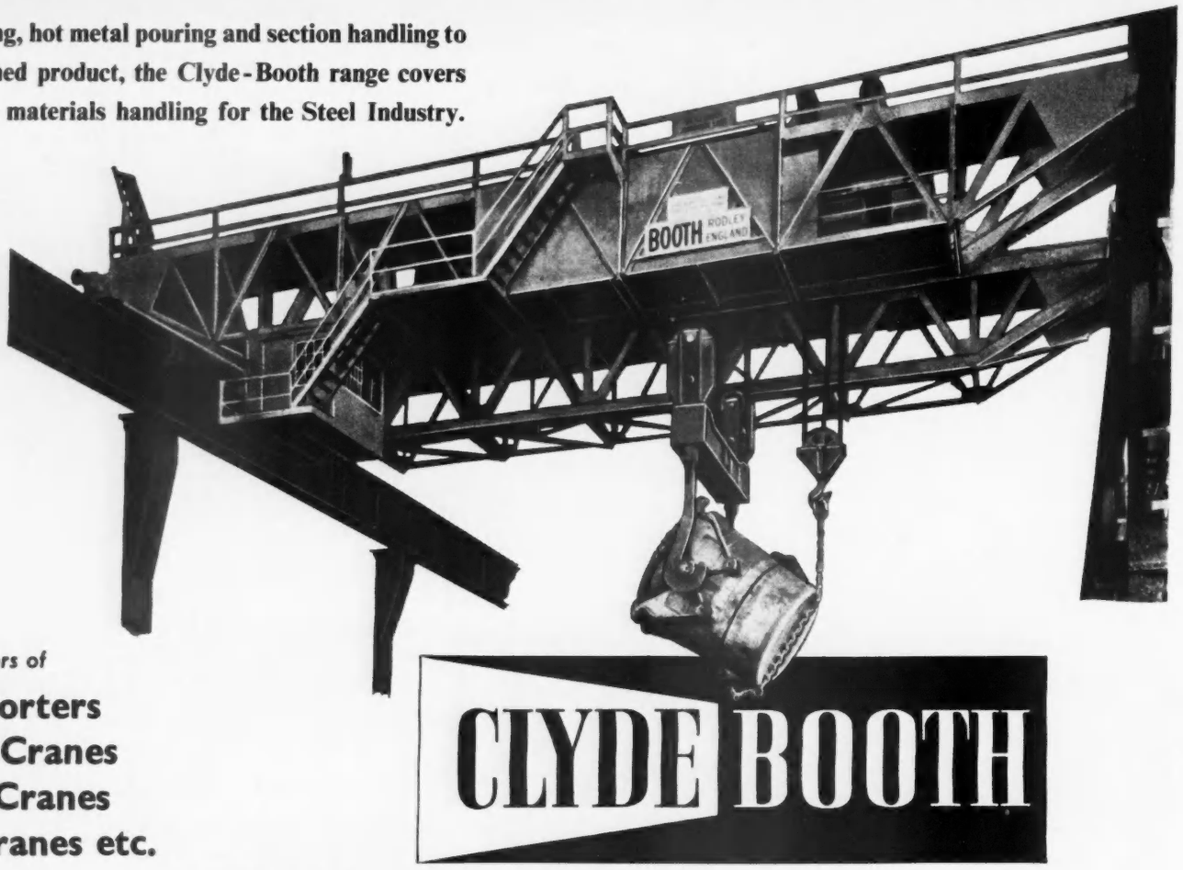

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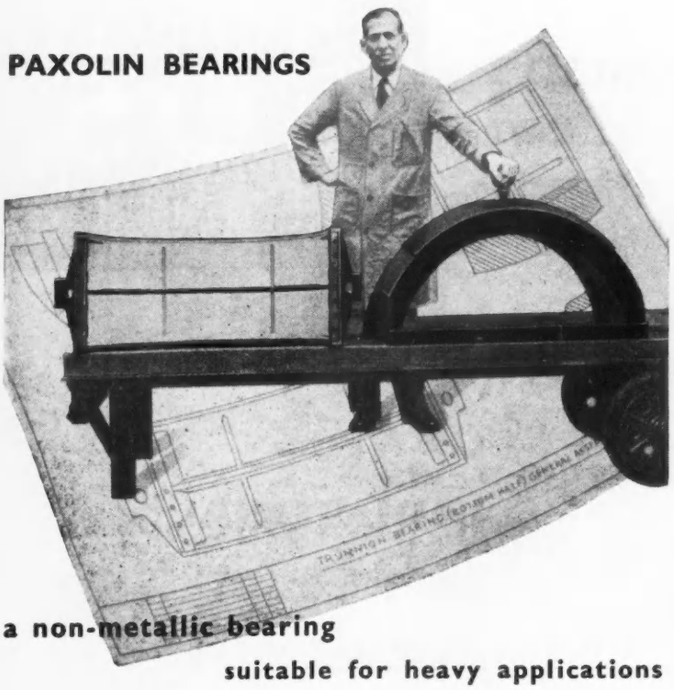

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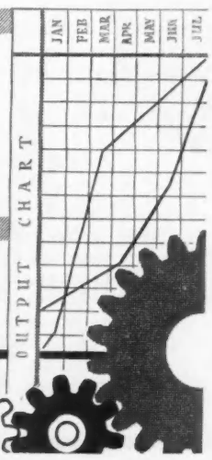

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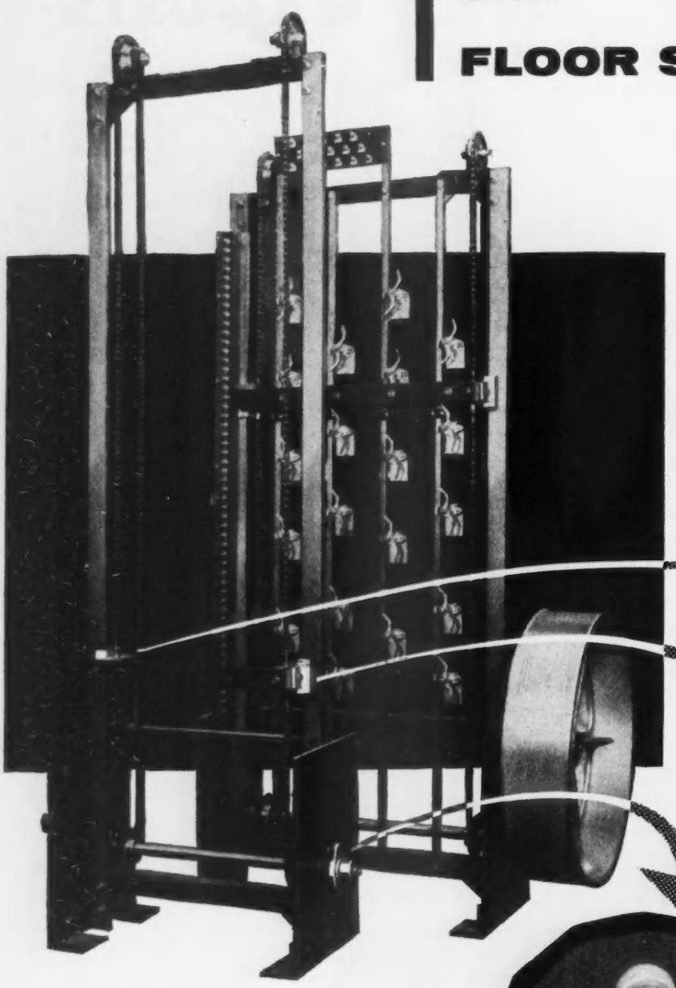
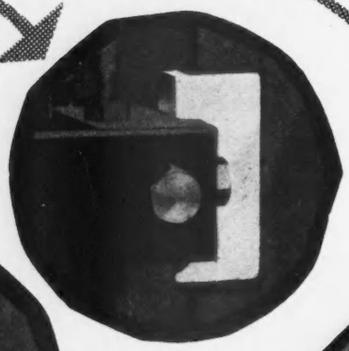
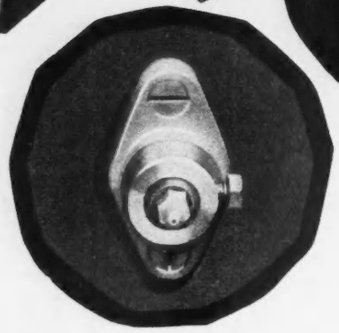
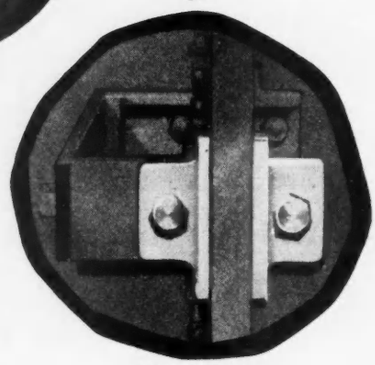




Slide bearing front view



Plain bearing



Slide bearing side view

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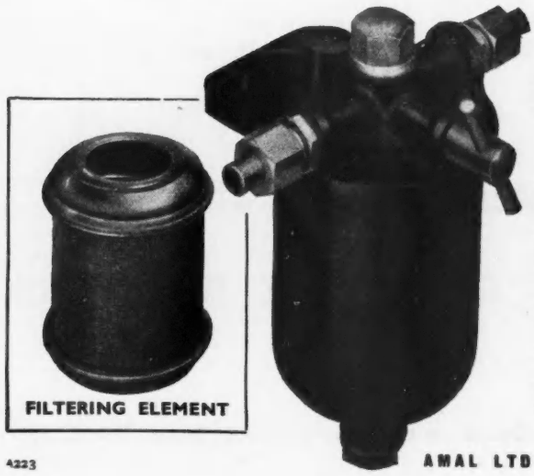

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This type 166 filter is robust and efficient and capable of passing 150 pints per hour at 1'-0" head.

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Made in two sizes 5¼" deep or 10" deep, the 10" model giving a proportionally longer interval before filter element cleaning is required. Approximate diameter of filter in both cases 3¼".

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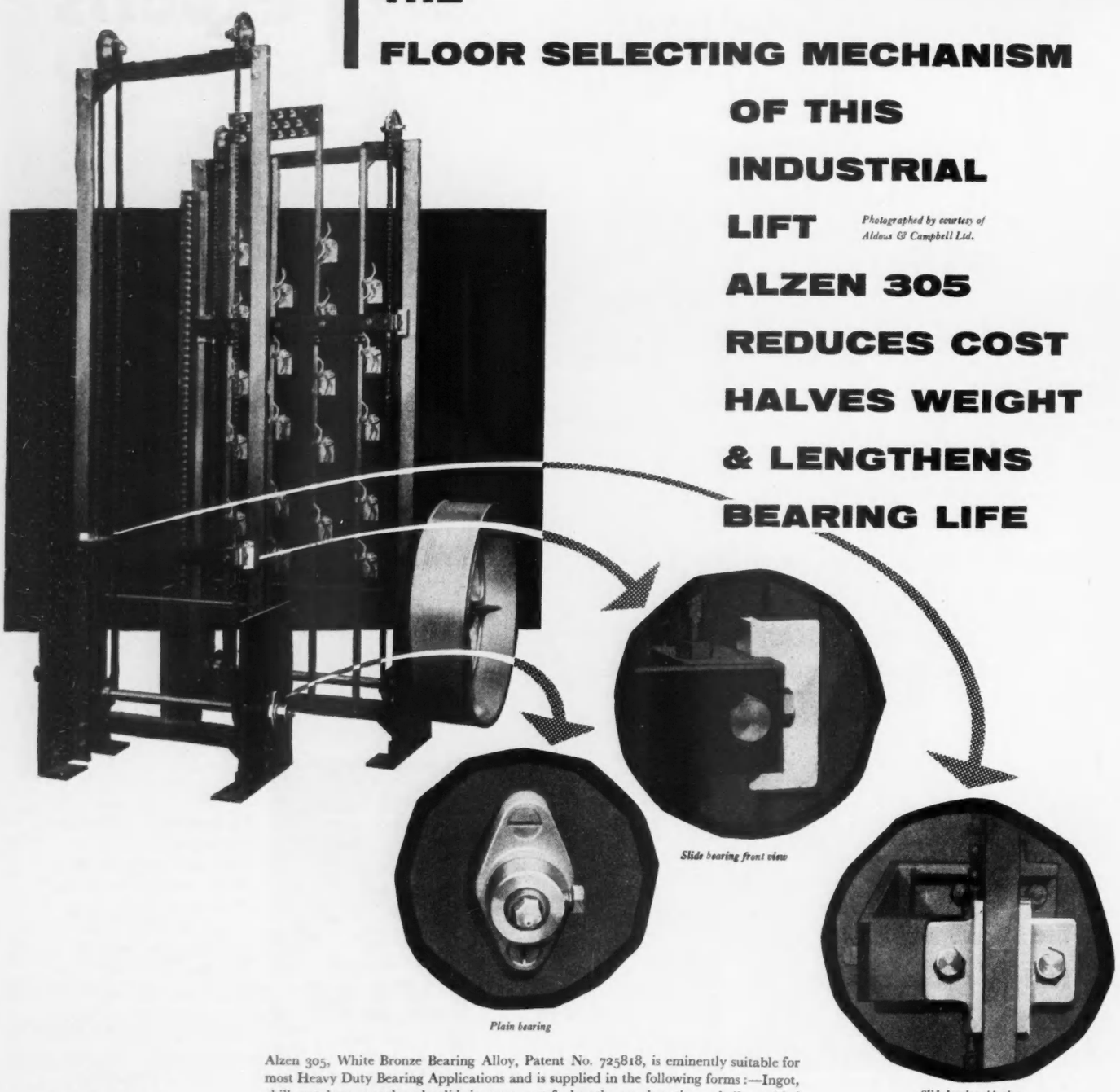

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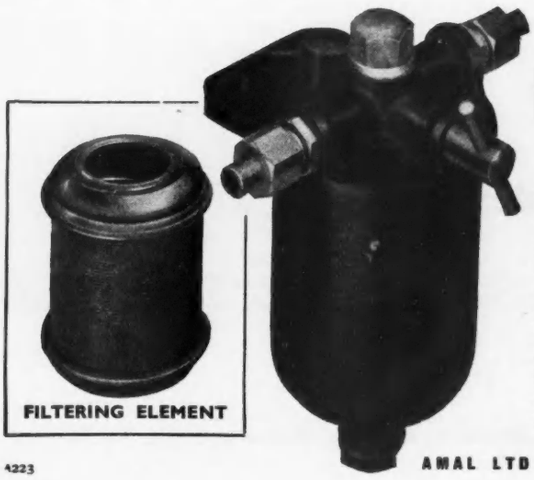

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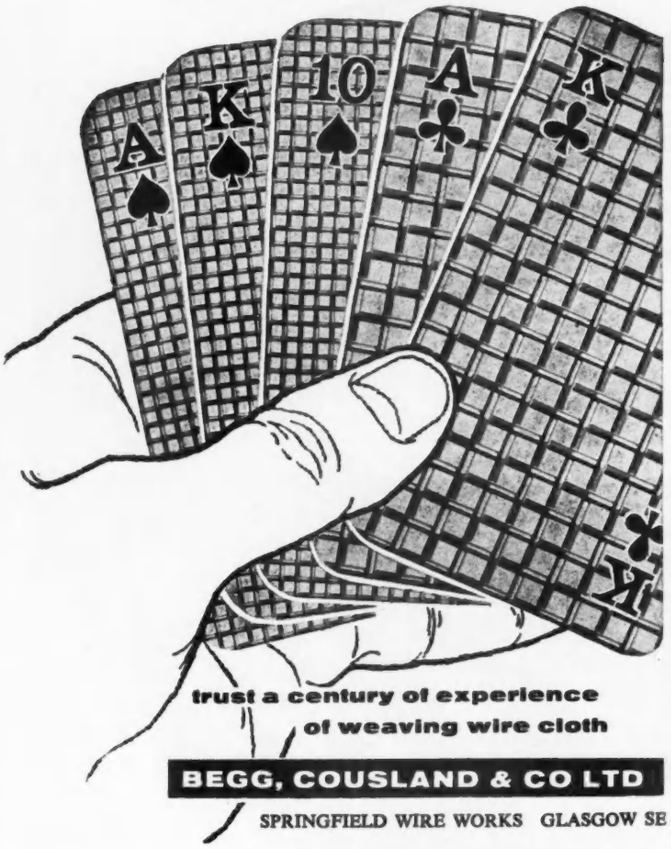

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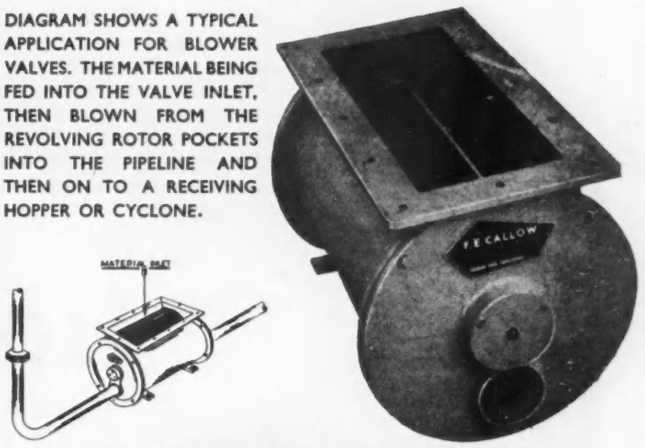

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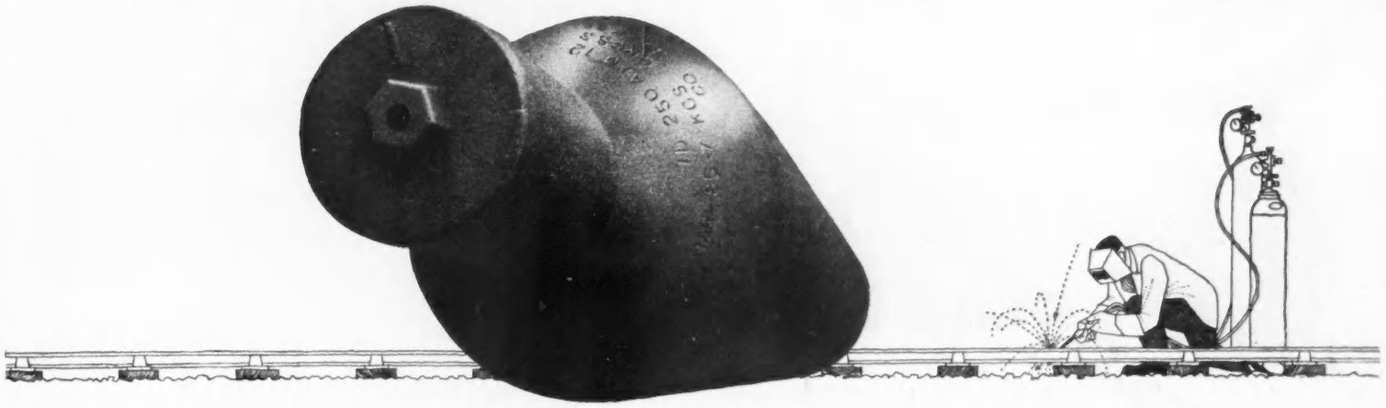

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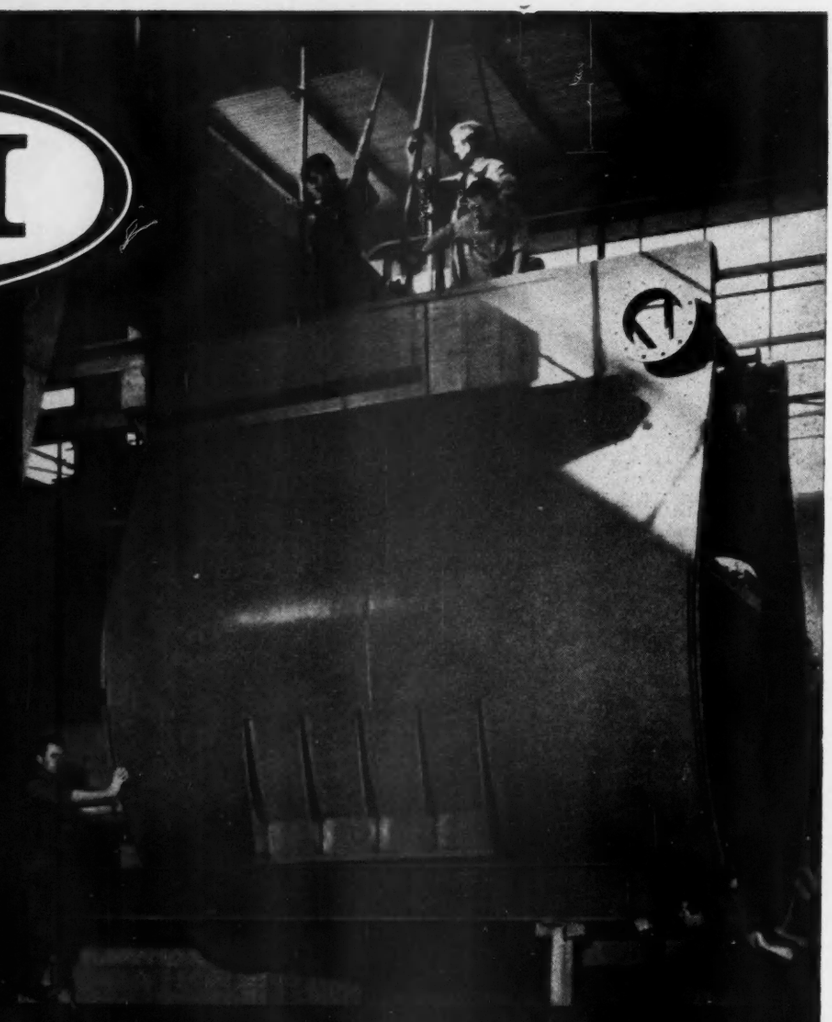
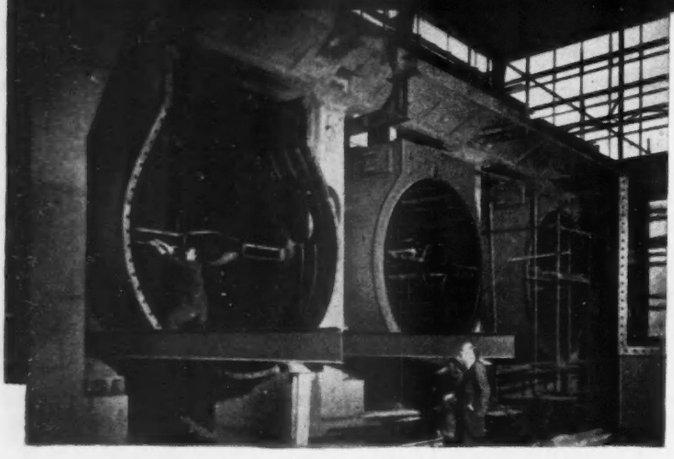


One unit of a three-shell surface condenser being placed in position at Berkeley, the commercial nuclear power station now under construction in Gloucestershire by the A.E.I.—John Thompson Nuclear Energy Company.

FOR BERKELEY NUCLEAR POWER STATION



A general view of three condenser shells in position at Berkeley.

The entire turbine-house heat exchange equipment for the new power station at Berkeley is being supplied by the A E I Turbine-Generator Division, and manufactured at their factory at Germiston Glasgow.

Four three-shell main condensers — one for each of the four 83 MW mixed-pressure steam turbine-generators also being supplied by A E I.

Two-stage feedwater heating equipment for each turbine-generator.

Two 'dumped' steam condensers to handle surplus steam generated when commissioning the reactors, or in the event of a sudden shut down.

Other equipment in manufacture includes the steam jet air ejectors, water/water heat exchangers for the generator cooling circuit and general gas circulator service, oil coolers and generator hydrogen cooler units.

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ENGINEERING Impact

of Europe's Energy Market

The guiding principle in the new OEEC report "Towards a New Energy Pattern in Europe" on the pricing policies for the different types of fuel, is to let the market decide. "The paramount consideration," it states, should be "a plentiful supply of low-cost energy with a freedom of choice for the consumer." That is a proposition unlikely to be enthusiastically welcomed.

A free market and a nationalised monopoly do not go together either in the economic textbooks or in the sales offices of the National Coal Board. This is true for other European countries as well as Britain.

What advice has the report to offer to those grappling with the coal problem? For the most part it understandably states principles rather than draws blueprints for action. Price differentials between different fuels should "secure that each is used for the purposes in which it can be employed to the best advantage." Publicly owned bodies should be "expected to pay their way and not pass on to taxpayers part of the true cost of the undertaking." Both statements are unexceptionable but hardly the sort of things likely to be acceptable to the coal industry.

Supply

On the supply side the report forecasts that unless the price of coal makes its use "fully competitive" with other forms of energy and the "upward drift" of production costs is arrested, the market will contract. A flexible price policy is seen as preferable to attempts to stabilise prices for coal. Since 1913 the relative price of coal, compared with other wholesale prices, has risen in all industrial countries. But since 1946 the relative American price has either been constant or falling. Crude oil prices over the same period have varied closely with the average of all other wholesale prices. Coal prices have moved up faster states the report because wages have gone up ahead of productivity. The suggested cure for this is the concentration of production "where the prospects of increasing productivity are greatest." The industry should not be made to continue to carry social welfare burdens that have outgrown its strength. These as well as the cost of resettling miners from redundant pits should be shared by the whole economy.

On methods of carrying out policy, the Committee must have had some lively discussions. The *dirigiste* attitude of some of the European Coal and Steel Community countries and indeed some interested parties here, that the object of policy should be to tell the consumer what he can have and then see that he gets it, is firmly turned down.

As the report states, lowest cost energy is a matter of availability of cheap sources of energy and of its use in the most efficient way possible. To secure these objectives the report comes down firmly on the side of the free market. Prices should reflect costs and scarcities of individual types of energy. On the framing of policies the report says nothing. But on the need for them it states, "We do not know of any member country which cannot provide examples of pricing policies and taxation policies which inhibit the efficient use of energy." There is nothing new in all this. The sad thing is that having it said again in an OEEC Report is not going to help anybody.

Kremer Conditions

In a world where research is carried on by teams at universities and by departments of the big companies the Kremer Man Powered Aircraft competition brings a more than welcome chance for the lone inventor, the man with the unique combination of common sense and vision.

The Royal Aeronautical Society, which has now published the conditions under which the competition for the £5,000 prize will be conducted, has an official sounding Man Powered Aircraft Group, but its conditions leave the field wide open for the gifted individual.

These conditions are:

1 The entrant, designer and pilot must be United Kingdom or Commonwealth citizens and their aircraft must be designed, built and flown within the Commonwealth.
2 It must be a heavier-than-air machine powered and controlled by the crew over the whole flight. No lighter-than-air gases or devices for energy storing are permitted.
3 No limit on the number of crew.
4 Flights are to be in still air, i.e. wind not above 10 knots, and from level ground. The course to be approved and the flight observed by the Royal Aero Club.
5 The course to be a figure of eight with two turning points not less than half a mile apart.
6 The height, both at start and finish of the course, must be not less than 10 ft above the ground.
7 The aircraft must be in continuous flight over the entire course.
8 No certificate of airworthiness will be required but all entrants must have third party insurance.

The post-war years have seen in the Folland lightweight fighter aircraft, and more recently in the British Motor Corporation's Minicars, how fresh thinking can revolutionise the accepted practice.

It is to be hoped, and it seems a reasonable likelihood, that with modern methods and materials, man may be within sight of overcoming his centuries old inability to get up in the air and stay there without either an engine or a helpful slope of hillside.

A Nation of Aircraft-Engine Makers

The record export figures achieved by the aviation industry last year show two distinct features, one promising the other not so re-assuring.

The first is the strong and improving position of the export of British aircraft engines. While the total export from the industry went up by just on £2 million, to £156,056,066 the sales of engines increased over 1958 by 30 per cent, to £64,500,000. From a sale of aircraft and parts in the first half of 1959 of £54 million, the second half of the year saw these decline to £31 million. Engines and parts rose from £30,500,000 in the first half to £34 million in the second.

Not so re-assuring is the large part played in the industry's figures by the sale of spares for the 400 British airliners and several hundred military aircraft in service abroad. Unless the New aircraft due from the British makers in the form of the DH 121 and others can make a sizeable impression, despite the overall supremacy of the DC 8 and the Boeing 707, this field for sales is none too reliable.

For the immediate future of the industry's present products, orders were received last year for Comets for Greece and Mexico, Britannias for Argentina and Canada, Canberras for Iraq and Sweden, missiles for Australia and Sweden, and there were six more Viscount customers.

The Ford Method Triumphs

The return of the Ford motor company to Lancashire (the British offshoot of the American concern began life outside Manchester), and the pattern of the British Motor Corporation's expansion into Scotland, are strong evidence of a movement in motor firm management towards the Ford way of doing things.

At Dagenham, as Ford officials always proudly tell their visitors, they start from the docks and the blast furnaces and largely make the vehicle there. The quickest way to alter the smiles of the officials is to loosely call the booming Dagenham works "another assembly plant."

The British Motor Corporation has never been like this. A loose "federation" of component makers and assembly plants spread through the Midlands and taking in Oxford; the virtues of the BMC have not been those of Fords, who if they wanted a motto might have sought the Latin for *All in the One Spot*.

In going to Halewood, between Liverpool and Widnes, Ford are not departing from their production philosophy. Halewood will not be a division of their forces. It will be another complete army, employing 8,000 workers in the production of 200,000 cars a year. For the North-west the Ford announcement is vastly more than a gleam on the horizon. The first Consuls and Anglias, of whatever shape they may by then have attained, may be carried through the Lancashire streets before 1962 is out. More and more Ford export achievements are led by their sales in the United States. And Liverpool is plainly better located for that trade than Thames-side Dagenham.

Other work for subsidiary engineering firms within reach of Halewood will follow, the distributive trades will have a shot in the arm, John Summers at Shotton will have further demands for its sheet steel.

Pattern

And the BMC, intentionally or not, is following the Ford pattern. While moving out to Scotland, South Wales and to Merseyside, it is at the same time centralising car production at its main Midlands centre.

The Corporation is achieving this move in two directions by sending further afield its domestic appliance, tractor, and commercial vehicle sections, and also some car body work. Car assembly, with ever greater finesse in costing and production control is centred on the Midlands, where BMC is thus able to spend above 50 per cent of its development capital.

Safety on Site

Strenuous efforts have been made for the past two years by the Ministry of Labour to promulgate safety legislation for civil engineering sites. Completion of the regulations has been made more difficult by the differing work that falls under the heading of civil engineering—tunnelling, erection of steelwork, and heavy excavation are only three of the variants. But the tragedy at Barton Bridge, where two men were killed while high-level girders were being jacked into position, has brought the matter to the attention of both Parliament and the general public so that legislation should follow quickly.

The Federation of Civil Engineering Contractors have been giving every assistance to the Ministry in the efforts to compile adequate regulations. They have collected data on accidents and sought to find the basic causes. No amount of regulations can be as effective as awareness by the people concerned of the risks entailed by certain practices. The training courses established by the Federation for key personnel—agents, site engineers, foreman and gangers—can do much to help.

Last year courses were provided at centres in London and Birmingham and the industry responded by asking to send more men than there were vacancies. New centres are now to be established on Merseyside and in South Wales and Scotland. The Federation expect that their courses will soon be running at the rate of at least twenty a year.

and Post Office Auto-Sales

Living up to its reputation for leadership, the Post Office is to install a drive-in "automated" counter at Luton's main post office in June.

The new departure will be part of the newly built £250,000 post office in the town, which also has an electronic sorting machine.

Leicester post office already has a drive-in counter where motorists are served by clerks. Post Office machines for selling stamps are nothing new but at the special Luton counter there will also be machines for dispensing letter cards and envelopes, all without the drivers leaving their seats.

The automated drive-in post office counter, or shop of any sort, has welcome possibilities for ending the shoppers' bondage to the nine-to-five day of the distributive worker. If the auto-sales machine reverses the trend towards more and more people being employed in selling, its significance will be further afield than in the High Street and the corner shop.

It only now wants the National Coal Board to follow the French example of providing bags of coal in an auto-sales machine, but arranged as a drive-in, and we shall be on the way to the day when the only shopping done on foot is for shoes.

Resin Bonded Ptfe as a Bearing Surface

Low compressive strength and high sintering temperature of ptfe offset its attraction as a low friction material. These are largely overcome in resin bonded coatings which are now commercially available.

By E. R. Braithwaite

Acheson Colloids Limited

Since the development of ptfe resins, much interest has been shown in their lubricating properties due to the fact that at low speeds and loads ptfe exhibits the lowest known coefficient of friction; unfortunately there are some disadvantages when ptfe resins are used alone as solid film lubricants. The resins have a very low compressive strength (about 2,000 lb per sq. in) and this allows the films to cold flow which thins out or removes the resin from the bearing surface giving metal to metal contact and ultimate seizure. Ptfe is a very good thermal insulator and this is not a desirable property for a solid lubricant which must be able to conduct frictional heat away quickly and efficiently from contact surfaces. Its main drawback, however, is applicational, for the relatively high temperature (approximately 370° C) required to sinter or form a coherent film on a surface is within the toxic range for ptfe resins and excludes its use on wood, plastics, low melting metals or precision made parts.

It is possible to partially overcome some of these problems by mixing with graphite or molybdenum disulphide to the extent of about 50 per cent by volume. It has been reported that such additions increase the resistance of ptfe films to load deformation by an order of magnitude and the wear resistance by 500 times. In addition, both thermal conductivity and hardness are considerably increased. One of the most successful applications of filled ptfe is its use in impregnated metal bearings. In such bearings the matrix is a sintered spherical bronze and the optimum ptfe/bronze ratio is greater than 30 per cent by volume ptfe. In addition such surfaces have a "flash" coating of ptfe which facilitates running-in. Following the running-in period ptfe is squeezed from the bronze matrix to protect the bearing surface, and the bearing will then function under suitable conditions for up to a thousand hours.

It has been shown that the frictional force between a plastic surface and a metal slider (neglecting the ploughing factor) is equal to the bulk shear strength of the plastic times the effective area of contact. While this is true in most plastics, this relationship is not followed by ptfe which gives frictional values that are very low compared with bulk value except in the temperature range near the softening point. This may be due to the anisotropic nature of ptfe and in this respect it resembles graphite or other lamellar solid lubricants. It is generally accepted that the relatively large fluorine atoms in ptfe

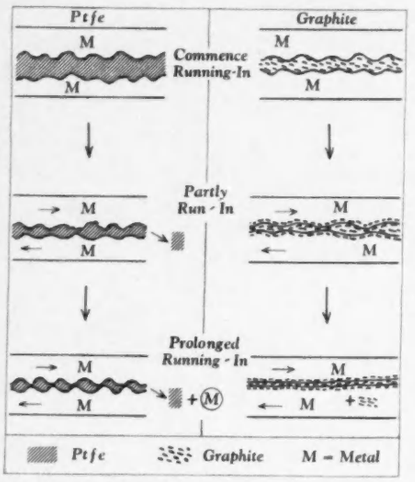


Fig. 1 Graphite and ptfe lubrication mechanisms.

are able to shield the smaller carbon atoms, and the molecules, which are long stiff fibres, do not interpenetrate and can roll over one another. Thus the lubricating mechanism is different from that of the solid lubricants such as graphite or molybdenum disulphide. Solid lubricants in general depend for their lubricating action on high tensile strength in at least one dimension, the presence of surface films and their ability to form "Beilby layers" with the rubbing metal surfaces represented schematically in Fig. 1.

Ptfe, on the other hand, is removed from the surface, its stay being dependent on rubbing speed, load and temperature, and while there is definite evidence that plastic materials do follow some form of adhesion mechanism, there is definitely no evidence of metal/plastic solid solution by the metal/plastic components, although there is evidence of plastic/metal solid solution due to pick-up.

Because of the applicational difficulties in films of pure ptfe, the possibility of dispersing very fine particles in resin solutions has been investigated, and in principle, such dispersions are not unlike colloidal dispersions of other solid lubricants. Obviously the choice of resin is of major importance for this will largely decide the temperature at which a sprayed film of ptfe and resin will cure.

Results have indicated that a combination of ptfe and phenolic resins has advantages, and this is the basis of "Emralon" resin bonded ptfe made by Acheson Industries, Inc. Structurally, a dry film of Emralon is not unlike the ptfe/bronze sections discussed earlier in that a film of Emralon consists of ptfe dispersed in a phenolic matrix which not only acts as a support for the ptfe, but also has good intrinsic wear characteristics and therefore to a very limited extent improves the load bearing characteristics.

It is evident from Fig. 2 that when a coating of Emralon is applied to steel, a desirable range of friction is obtained when the film thickness is between 0·2 and 0·8 mils; this is in contrast to graphite or molybdenum disulphide which can function at film thicknesses so small as to be detectable only by electron optical techniques. This emphasises the important difference in lubricating mechanisms, namely that Emralon operates by wearing away, while graphite functions by wearing away and running in. When the Emralon film is too thin the friction and wear increases, probably due to the exposure of asperities by film breakdown (Fig. 1) and when the film is too thick, plastic flow occurs with a resultant decrease in thermal conductivity. The coatings ball-up and again there is an increase in the coefficient of friction.

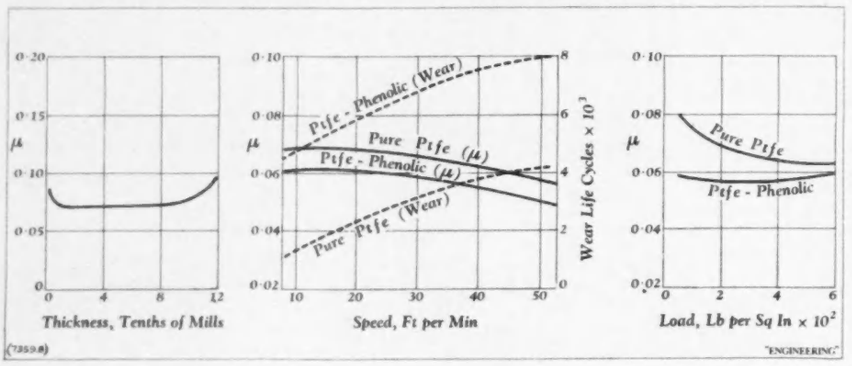
Film thickness largely determines the wear-life of coatings. The skeletal matrix is also of importance as it determines not only the rate of release of ptfe but also its distribution. The number of particles per unit volume and the ratio of particle size to average size of resin units all affect wear life. Such quantities are controlled by adjusting the compatibility of the ptfe with the resin matrix; work continues along these lines particularly in the distribution of ptfe through the resin matrix.

Emralon has twice the wear life of pure ptfe dispersion, while Fig. 2 indicates the effect of running speed. The coefficient of friction is at least as low as that for ptfe and it is recommended that a safe operating zone is at speeds up to about 50 ft per min and loads not exceeding about 300 lb per sq. in. It should be noted that the corrosion resistance of an Emralon film is not quite as good as that of pure ptfe, for this factor is obviously dependent on the weakest component—the phenolic resin.

Emralon is available in two forms. Emralon 810 is a dispersion of ptfe in a phenolic resin and is manufactured by arrangement with Du Pont, USA. It can be cured at lower temperatures (150° C for one hour) than is required for the sintering of ptfe and the films can be applied to rubber, metal, plastics and other materials able to withstand the curing temperature. The film will withstand temperatures up to 200° C for limited periods and 175° C in continuous operation. When coated on cadmium or steel plate it will withstand the standard salt spray for over 300 hours. A second dispersion, Emralon 820, is available which does not require baking; films formed from this material will harden at room temperature and it can therefore be applied to metals, plastics and other rigid substrates.

Major uses of Emralon in this country and the USA can be divided into two main sections: where absolute cleanliness is essential, and where loads and speeds are low, and high baking temperatures are not encountered. The first category includes packaging equipment, paper shutes, food, grain and chemical dispersers and various intricate mechanisms in the textile industry. The second category includes the treatment of aerofoil sections, airscrews, air intakes and ancillary equipment such as duralumin piston rings for the aircraft industry including also its use to minimise frettage corrosion. Cinema camera magazines, piano parts, clockwork fuse mechanisms, rubber moulds and Bowden cables can all be satisfactorily lubricated by Emralon and its useful range appears to be expanding rapidly.

Fig. 2 Properties of resin bonded ptfe coatings.



Flocculating Agent

A new flocculating agent in granular form has been developed by Cyanamid International. In plant and field trials, this high-molecular-weight polymer has consistently outperformed other synthetic and natural polymers as a filtration and settling aid for solid-liquid separations.

Known as Superfloc 16, the product is particularly effective in thickening operations for increasing settling rates and overflow clarity. In addition to uranium mining, Cyanamid expects to find wide application in the clarification of coal plant effluents as well as in other areas of the mining industry where solid-liquid separations are a problem. It may also be used to treat water and suspensions of sewage, industrial wastes and chemical precipitates.

In settling acid-leached uranium ore at a Canadian countercurrent decantation plant, 0·06 to 0·11 lb of Superfloc 16 per ton of ore have provided the same settling rate, overflow clarity and underflow fluidity and density as 0·11 lb per ton of the previously used product. Other plant trials at Colorado plateau uranium operations, which also use countercurrent decantation for solid-liquid separation, have shown that the flocculent decreases soluble uranium losses by increasing underflow densities 5 to 7 per cent.

Cyanamid of Great Britain Limited, Bush House, Aldwych, London, WC2.

Plastic Doors for British Railways

Under the disguise of doors, plastics are permeating the hallowed precincts once ruled over by cast iron, steel and timber; in other words, British Railways rolling stock. Next time the train door shuts with a deafening thud think how much lighter are plastics; next time the fares go up think of how much less they would have done if the basic material for rolling stock were

Doors are made in two halves by hand lay-up.

plastic. Such thoughts as the last one would unfortunately not hold much water, but in the case of the doors recently introduced on the Southern Region electric trains it would be a thought in the right direction—money was saved.

Plastic faced doors with aluminium frames are widely used on electric rolling stock and such Warerite laminates have also been used to line whole compartments. This is one of the first uses of glass reinforced plastic in this country. Southern Region's Carriage and Wagon Works are where these doors are now made in quantity production using a fire-resistant grade of Bakelite polyester resin. In resistance to deformation and permanent set, these doors have proved themselves fully capable of withstanding continual heavy slamming.

In production by hand lay-up the layers of chopped strand glass mat which are impregnated with resin are consolidated in a mould which itself is made of reinforced plastic. The inside and outside halves of the door are made separately and then immediately clamped together.

Metal plates for the fixing of hinges, locks and locating pins are moulded into the material during manufacture and a felt lined steel channel is included to take the sliding window when it is fitted. At first an independent reinforced-plastic door well, which drained water out through the bottom of the door, was put between the two halves when they were clamped together; it proved unnecessary and in later versions has been eliminated.

Being unaffected by weathering the doors do not need surface protection, and painting is only carried out so that the colour and surface match the surrounding metal parts of the carriage. The surface layers of resin are pigmented green, so that if scratches do remove the paint the marks are not so apparent.

Bakelite Limited, 12 Grosvenor Gardens, London, SW1.

New Magnesium Alloys

Thorium and rare earth metals are added to two new alloys now marketed by Magnesium Elektron. They are known as ZTY and MSR; the first being a wrought alloy with good properties at elevated temperatures and the second a casting alloy with a room-temperature proof stress comparable with high-strength aluminium alloys and which has very attractive creep properties at elevated temperature, especially at 200° C.

ZTY is a 0·7Th-0·5Zn-0·6Zr-magnesium alloy and is available as sheet, plate, extrusions and forgings. It may be hot formed without difficulty and develops full strength without heat treatment. Typical properties at room temperature are 8·5 to 12·5 tons per sq. in for 0·1 per cent proof stress, 15·0 to 18·0 tons per sq. in in ultimate tensile strength with an elongation of 10 to 20 per cent, the lower values having been proposed as minima for a DTD specification. The proof strength is retained at this figure up to about 180° C, is still 10 tons per sq. in at 200° C, and is reduced to half this figure at about 290° C.

Test bars in MSR, which is a 2·5Ag-2rare-earth-0·6Zr-magnesium alloy, show 0·1 per cent proof stresses of 10 to 13·5 tons per sq. in and this is the best of all magnesium-base sand-casting alloy in the range 0-250° C. Both this and the former alloy are suited for light rigid components especially as might be used in aircraft or missiles.

Magnesium Elektron Limited, Clifton Junction, Manchester.

Aluminium Alloy out of this World

On those occasions when an American missile manages to get clear of our little sphere of influence it will probably be carrying with it a number of aluminium castings made from a new alloy which is called Tens-50 by the makers, North American Aviation.

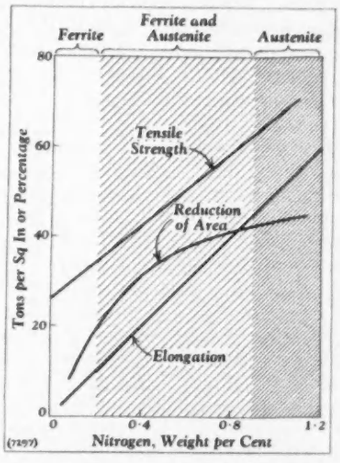
The composition is 8 Si-0·5 Mg-0·2 Be-0·15 Ti-aluminium with limits placed on zinc, copper, manganese, iron, chromium and total impurities at maxima of 0·2, 0·1, 0·2, 0·3, 0·2 and 0·15 per cent respectively. This is one ingot specification covered by US Patent 2,908,566. Use is well established, apparently, for the majority of aluminium castings in the liquid rocket engines used in American missiles. The alloy does not closely resemble any standard alloy but is notable for the small amount of beryllium. This is said to prevent brittleness which may arise, the company say, in such compositions through pick-up of iron during melting.

North American Aviation, Incorporated, International Airport, Los Angeles 45, California, USA.

Nitrogen-containing Steels

Nitrogen in steels is very much like carbon. It has a similar equilibrium diagram, goes into solid solution in iron and forms nitrides similar to carbides. One of its potentially useful properties is that it will stabilise the austenitic phase, as will manganese and nickel; in fact, a similar structure is obtained in 18Cr-2Ni-stainless steel if the nickel is wholly replaced by 0·2 per cent nitrogen.

At the laboratories of the British Iron and Steel Research Association, work is in progress to find out just how much nitrogen will dissolve in steel. One of the first results obtained has been



Effect of nitrogen on 28 Cr-stainless steel.

to confirm that chromium increases the solubility of nitrogen in iron. Measurements of mechanical properties have been made on otherwise ferritic steels containing high chromium contents. With one containing 28 per cent the structure obtained varied from fully ferritic to fully austenitic above 0·9 per cent nitrogen, and toughness was increased on water quenching any of these structures from 1,200° C. Nitrogen has the useful property of increasing both the strength and the ductility.

Air Drying Hammer Finish Enamel

A new synthetic enamel provides a hammer finish in one of a limited range of colours after air drying. Carltonian hammer finish is a product of Wareing Brothers. It dries dust free in 30 minutes and can be handled in about 4 hours; however, due to the thickness of the film it does not become thoroughly rock hard until the next day. The drying process may be hastened by mild stoving treatment. The paint may be applied directly on to bare metal or to other surfaces by any standard spray equipment, the spraying pressure of 50 lb per sq. in being recommended.

This enamel is resistant to oil, petrol and heat and withstands the action of mild acids and alkalies. While mild heat only speeds the drying out without affecting the hammer finish, this is not so with thinners and these should be avoided.

Wareing Brothers and Company Limited, Carlton Street Works, Bolton.

Plain Words

By Capricorn

Americans are more addicted than we are to the practice of adorning the office wall with slogans and mottoes for the rising executive. When I was in lodgings, training to be an engineer, my landlady was fond of the Victorian variety, usually a religious message presented with ample flowers and twirls and twiddly bits. She was also in the habit of blaming any phenomenon she didn't understand on " the electric," believing that electricity had some connection with the devil himself.

The fact that the modern version of the inspiring text is functional and contemporary in its design does not dissociate it in my mind from the admonitory, finger-wagging seriousness of the Victorian version. What saves it from pomposity and gives it an unfair power to convey a message is the flippancy of its message. It is not easy to ignore the humorous, though it was not difficult to forget the serious.

I suppose now that what really irked me about the text that was hung over the bed in my digs was the frightening assumption that one message out of thousands of possible messages could be put on the wall to remind you of your duty day in, day out; year in, year out. Life is full and varied, exciting and unknown—so why permit this oversimplification? Today it would be fun to collect the Victorian texts, laying your hands on as many as you could find, and then decorate your office with them. Cover the walls in a splendid profusion of advice and instruction, remind this delinquent generation of the sentiments that made Britain great, revive the teaching of Samuel Smiles, grow a beard to look the part, and then adjust the light that falls on your face so that the light and the beard together leave your staff and visitors guessing whether you have a rather elaborate sense of humour or a serious streak in your make-up.

I commend this idea to anyone who, because of the nature of his position and work, has to create a very forceful impression and if possible get talked about. For most of us it is more necessary to fit in with the organisation by acquiring a nicely balanced mixture of unobtrusiveness and influence. Can we, then, afford just one carefully chosen text? If we search until we find the one quotation which exactly fits the character we wish to put over, maybe it will help us to develop that character. People will expect us to live up to the words on the wall.

This is really an exercise in public relations, and what man would dare to be his own PRO?

I think I could have a shot at it myself: I would choose a slogan about delivering things on time—not only because it is perhaps the most important single mark of good business but also because I have to keep reminding myself of its importance. I am already late with this for the printers.

Did I suggest that texts are out of date?

Letters to the Editor

Engineers' Portraits

SIR, It was interesting to read the remarks by Capricorn in Plain Words recently regarding his visit to the National Portrait Gallery (ENGNG., 18 Dec. '59, p. 630).

I note the two 20th century engineers who were picked out as not represented in this collection. I have been in touch with a relative of one of them who has given me a list of portraits known to him. From this it does not appear likely that it will be possible for him to be represented by an original or replica for some years to come. I do not know of an available portrait from life of the other.

One of the trustees' rules is: " That no portrait of persons still living, excepting only of the reigning sovereign or of his or her consort, shall be admitted." This is quite a good rule in many respects; but it means that frequently the best or even all portraits of distinguished persons have found permanent homes before the trustees of this gallery are able to consider the acquisition of one.

Yours sincerely,
C. K. ADAMS,
Director.

National Portrait Gallery,
London, WC2.
3 February, 1960.

Editor's Note.—In the Plain Words referred to Capricorn expressed the view that portraits of Sir Charles Parsons and Sir Henry Royce should be included in the gallery's collection.

Recovering Iron Oxide from the Air

SIR, In your article " Making Air Fit to Breathe " (ENGNG., 29 Jan. '60, p. 174), reference is made to plant for the suppression of the dense brown fumes given off in the oxygen processes of steel manufacture. The article then states that a method of recovering this oxide in a useful form has been developed and applied successfully on the Continent, and that its application seems likely to spread. A wet process of suppression and reclamation of the finely divided iron oxide is then described briefly.

I would like to make the point that a dry process for the recovery of this oxide has also been developed and applied very successfully on the Continent and we believe that this process offers important advantages over the wet process to which you have referred.

In fact, the dry dust collected from the precipitator plant installed by the Oesterreichische Alpine Montangesellschaft on their L/D converter at Donawitz in Austria is discharged directly into paper bags which are fed straight back into the converter, thus eliminating the return of this dust through the sinter plant and blast furnaces.

The dry process also has the advantage, of course, that it dispenses with the necessity for external sludge thickening and clarifying plant, water circulating and cooling arrangements, etc.

Yours faithfully,
J. E. SAYERS,
Chief Engineer.

James Howden and Company Limited,
195 Scotland Street, Glasgow, C5.
5 February, 1960.

Russian Profits

SIR, I was interested to read the letter from Mr. J. B. Aldred on the reason " why Russia must overtake the West in productivity " (ENGNG., 29 Jan. '60, p. 148).

He is not strictly correct, however, because if he would look at the Soviet annual budget he would see that the profits of industry form the second largest item of revenue.

Profits can be and indeed are made by Soviet industry, mainly on production above the plan. These profits are divided between the State budget, reinvestment in the factory, and on welfare work and bonuses for the factory workers. There is no doubt that bonuses give a material incentive to production in Soviet industry, but even more important is the fact that everybody knows that increased production is the basis for a rising standard of life and there are no such problems as redundancy and unemployment affecting the Soviet working people.

Yours, etc.,
PAT SLOAN,
General Secretary.

The British Soviet Friendship Society,
36 Spencer Street, London, EC1.
2 February, 1960.

Heavy Electrical Equipment

SIR, We would draw your attention to several errors in the Design section of your Outlook 1960 article on heavy electrical plant (ENGNG., 29 Jan. '60, p. 177).

Paragraph 2 of the third column refers to West Thurrock power station, stating that this station is to have two 200 MW AEI turbine-generators and two 300 MW Parsons sets. These should be reversed, as AEI are to supply the 300 MW sets. The same paragraph states that each unit will have the greatest single line output in the world. This may have been true at the time the orders were placed, but is not true now, and, in fact, is contradicted in the next paragraph of your article.

Still speaking of the second paragraph, the last sentence refers to direct water cooling, and makes no distinction in this respect between Parsons and AEI machines. The information on cooling is correct as far as AEI machines are concerned, but may be wrong if taken as applying also to the Parsons machines.

Further points concern the last paragraph of the same column; here again there is some confusion of information that is correct as far as AEI machines are concerned, but is incorrect when Parsons and AEI machines are grouped in a common statement. Speaking of the AEI and Parsons sets on Thorpe Marsh, it is stated that these sets will be the largest two-speed conventional cross-compound machines in the world generating at 50 c/s. Actually this applies only to the AEI set. The remainder of the paragraph needs careful overhaul, as it is clear you have quoted from the press notice we issued on the AEI set. As you have spoken of sets (plural), the information you have given on efficiency, speed and cooling arrangements, will be read as applying to the Parsons set as well. The Parsons set is not a two-speed machine.

Yours faithfully,
H. CLAYTON,
Press Liaison Section,
Publicity Department.

Associated Electrical Industries
(Manchester) Limited,
Trafford Park, Manchester 17.
3 February, 1960.

One Bedroom Dwellings

SIR, I notice in your journal a brief report entitled " The Right Homes for the Aged " in which you comment on the rise in the percentage of one-bedroom dwellings now being built (ENGNG., 29 Jan. '60, p. 153).

It is important to put these figures in the right perspective by saying that, although the proportion of one-bedroom dwellings built by local authorities reached 24 per cent in the quarter ended December 1959, it amounted only to 9·2 per cent over the whole period from 1945 to that date. Furthermore, by no means all of the 175,000 one-bedroom dwellings built during that period were allocated to old people. We must also remember that the total number of all dwellings built annually by local authorities has steadily decreased since 1953 and that few,

if any, one-bedroom dwellings are built by private builders.

Thus, while it is encouraging to see that more attention is being paid to housing for the aged, there is still a very long way to go if we are to begin to meet current demand, quite apart from making up for the past.

Yours faithfully,
M. R. F. SIMSON,
Secretary.

The National Corporation for the Care of Old People,
Nuffield Lodge, Regent's Park,
London, NW1.
3 February, 1960.

References by Code

SIR, The suggestion made by Mr. J. C. B. Williams (ENGNG., 11 Sept. '59, p. 147) that periodicals, etc., should be allotted codes for reference, is basically excellent and deserves further development.

We have found this need in connection with our punched card system for indexing technical literature, and we have met it by setting up a letter code for sources. This consists in allotting three letters from the first 15 of the alphabet to each source. This system allows individual codes to be allotted to 455 sources. A 4-letter code from 24 letters of the alphabet would allow 10,626 combinations.

We have preferred combinations rather than permutations (of which a very much larger number would be available) in order to simplify the operation of the punched card system.

Yours truly,
G. M. BOYD,
Technical Research Officer.

Lloyd's Register of Shipping,
71 Fenchurch Street, London, EC3.
1 February, 1960.

Events in Advance

Birmingham's Steam Weekend

A series of gas, steam and electrically-driven engines of historical interest are to be run for various periods at the City Museum, Birmingham, during a "steam weekend" arranged by the museum, which will take place on Saturday and Sunday, 26 and 27 March.

There will be three engines in the electrically-driven section, including the oldest example in the whole series. This is a semi-portable beam engine constructed by an unknown maker about 1820. A two-cylinder compound Corliss engine made by Pollitt and Wigzell in 1909 will be run for short periods only owing to power restrictions. The other electrically-driven engine is an orchestrion organ dating from about 1879. Included in the gas engine section will be three hot-air engines and a Tangye engine of 1904.

The seven engines in the steam-driven section will range from a compound beam engine of 1864 by Easton, Amos and Sons to a uniflow engine of 1924 by Galloway. Other exhibits in this section will include a steam hammer made by Massey in 1873, an Aveling-Porter steam roller of 1892, and a Ruston-Proctor portable engine of 1894.

Among other attractions of the weekend will be a reshowing of the film of the dismantling of the Ocker Hill engine (1777) and it is hoped to arrange for the showing of other films dealing with prime movers. The museum, which is situated in Newhall Street, Birmingham 3, is open from 10 a.m. to 6 p.m. on Saturdays and from 2 to 5.30 p.m. on Sundays. Additional information may be obtained from the Keeper, Mr. N. W. Bertenshaw, B.Sc.Tech., A.M.I.E.E., A.M.I.Mech.E., at that address.

Exhibitions and Conferences

Agricultural Machinery and Equipment Exhibition.—Sun., 14 Feb., to Sun., 21 Feb., at Brussels. Organised by the Société de Mécanique et d'Industrie Agricole, 29 Rue de Spa, Brussels 4.

Industrial and Commercial Refrigeration Exhibition, First.—Mon., 15 Feb., to Wed., 17 Feb., at the Old Hall of the Royal Horticultural Society, Vincent Square, London, SW1. Sponsored by *World Refrigeration*. Organiser: Mr. Patrick Smyth, 1 Crane Court, Fleet Street, London, EC4.

Automatic Vending Exhibition and Convention, Second International.—Mon., 15 Feb., to Thurs., 18 Feb., at the Royal Horticultural Society's New Hall, Greycoat Street, London, SW1. Organised by Contemporary Exhibitions Ltd., 40 Gerrard Street, London, W1. Tel. GERrard 4951.

Pilot Plants in Metallurgical Research and Development, Symposium.—Mon., 15 Feb., to Thurs., 18 Feb., at Jamshedpur, India. Organised by the National Metallurgical Laboratory, Jamshedpur 7, India.

Leather Goods Industries Fair, Eighth Annual.—Mon., 15 Feb., to Fri., 19 Feb., at Mount Royal Hotel, Marble Arch, London, W1. Organised by *Leathergoods*, 15 Cursitor Street, London, EC4. Tel. CHAncery 4001.

British Toy Fair.—Mon., 15 Feb., to Fri., 19 Feb., at Brighton. Organised by the British Toy Manufacturers' Association, 93-94 Hatton Garden, London, EC1. Tel. CHAncery 9158.

Scottish Dairy Show.—Tues., 16 Feb., to Fri., 19 Feb., at the Kelvin Hall, Glasgow. Organised by the Glasgow Agricultural Society, 51 Moss Street, Paisley, Renfrewshire.

Meetings and Papers

Chemical Society
NEWCASTLE UPON TYNE
"Why Polymerisation Occurs," by Professor F. S. Dainton. Newcastle upon Tyne Branch. Chemistry Department, King's College, Newcastle upon Tyne. Wed., 17 Feb., 6 p.m.

Combustion Engineering Association
HUDDERSFIELD
"Workings of the Clean Air Act." Discussion. Northern Region. George Hotel, St. George's Square, Huddersfield. Thurs., 18 Feb., 2.30 p.m.

Diesel Engineers and Users Association
LONDON
"Foundations and Mountings for Diesel Engines," by P. J. C. Teece. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 18 Feb., 2.30 p.m.

Illuminating Engineering Society
LIVERPOOL
"Light and Horticulture," by A. E. Canham. Liverpool Centre. Development Centre, Merseyside and North Wales Electricity Board, Liverpool. Tues., 16 Feb., 6 p.m.

Institute of Fuel
DUBLIN
"Liquid Fuel for High-Temperature Furnaces," by A. B. Pritchard and J. A. Taylor. Republic of Ireland Group. Engineers' Hall, 35 Dawson Street, Dublin. Wed., 17 Feb., 8 p.m.
LEEDS
"Developments in Internal-Combustion Engine Fuels," by W. S. Ault. Yorkshire Section. Metropole Hotel, Leeds. Wed., 17 Feb., 2.30 p.m.

Institute of Physics
LONDON
"Microstructures of Surfaces," by Professor S. Tolansky. Annual General Meeting. London and Home Counties Branch. Wed., 17 Feb., 6 p.m.
"Electroluminescent Image Intensifiers," by Dr. P. Schagen. Non-Destructive Testing Group. Fri., 19 Feb., 6 p.m.
MANCHESTER
"History of Science in Manchester," by J. G. Crowther. Annual General Meeting. Manchester Branch. The University, Manchester. Mon., 15 Feb., 6.30 p.m.

Institute of Road Transport Engineers
LONDON
"Wear and Tear"—Part 2, by J. E. Johnson. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 18 Feb., 6.30 p.m.

Institute of Welding
LONDON
"High-Pressure Pipelines in the Gas Industry," by F. W. Bell. Wed., 17 Feb., 7.30 p.m.*

Institution of British Agricultural Engineers
NEWCASTLE UPON TYNE
"Agricultural Aviation with Particular Reference to Aerial Spraying," by Dr. D. B. Blackett. Northern Centre. Offices of the North Eastern Electricity Board, Carliol House, Newcastle upon Tyne. Mon., 15 Feb., 6.45 p.m.

Institution of Civil Engineers
LONDON
"The Design and Construction of the Queen Elizabeth Graving Dock at Falmouth," by A. E. Underwood, J. D. Norfolk and J. N. Eathorne. Tues., 16 Feb., 5.30 p.m.*

Institution of Electrical Engineers
LONDON
"Soviet Control Engineering Progress." Discussion opened by R. E. Clark. Measurement and Control Section. Tues., 16 Feb., 5.30 p.m.*
"Electrical Machines," by Professor M. G. Say. Faraday Lecture. Central Hall, Westminster, SW1. Wed., 17 Feb., 6 p.m. (Admission by ticket.)
"Electricity in the Manufacture of Hydrogen Peroxide," by B. E. A. Vigers and R. O. Fletcher. Utilization Section. Thurs., 18 Feb., 5.30 p.m.*
LEICESTER
"Electrification of the United Kingdom Atomic Energy Authority's Industrial Group Factories," by J. W. Binns and W. J. Outram. East Midland Centre. Offices of the East Midlands Electricity Board, Charles Street, Leicester. Tues., 16 Feb., 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland
GLASGOW
"Vibration Problems in Marine Machinery and Their Solution," by W. McLaughlin. Tues., 16 Feb., 6.30 p.m.

Institution of Heating and Ventilating Engineers
SHEFFIELD
"Intermittent Heating of Buildings by Off-Peak Electricity Supply," by E. Harrison. Yorkshire Branch. Grand Hotel, Sheffield. Wed., 17 Feb., 7.30 p.m.

Institution of Highway Engineers
MIDDLESBROUGH
"Design and Installation of Corrugated Metal Structures," by P. R. S. Holmstrom. Municipal Buildings, Middlesbrough. North East Branch. Fri., 19 Feb., 7 p.m.

Institution of Locomotive Engineers
LONDON
"Trends in Transmission Design for Self-Propelled Diesel Railcars," by A. Gordon Wilson. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 16 Feb., 5.30 p.m.*

Institution of Mechanical Engineers
LONDON
"Electrical Equipment of the Automboile," by Dr. E. A. Watson. Crompton-Lanchester Lecture. Automobile Division. Wed., 17 Feb., 6 p.m.*
HARLOW
"Years of Development," by R. A. Wilson-Jones, chairman of the Automobile Division. Eastern Branch. Technical College, Harlow. Thurs., 18 Feb., 7.30 p.m.

Institution of Plant Engineers
MAIDSTONE
"Fire Protection of Industrial Premises," by F. Wain. Kent Branch. Queen's Head Hotel, Maidstone. Wed., 17 Feb., 7 p.m.

Institution of Production Engineers
BIRMINGHAM
"Application of Computers to Production Control," with film, by R. G. Hitchcock. Birmingham Section. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Wed., 17 Feb., 7 p.m.

Institution of Structural Engineers
GLASGOW
"Concrete," by N. M. Brydon. Scottish Branch. Joint meeting with the West of Scotland Branch of the Institution of Civil Engineers. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Fri., 19 Feb., 7 p.m.
LEEDS
"Future of Military Bridge Design," by E. Longbottom. Yorkshire Branch. Metropole Hotel, Leeds. Wed., 17 Feb., 6.30 p.m.

Reinforced Concrete Association
LONDON
"Lightweight Concrete Aggregates," by Professor R. H. Evans. Institution of Structural Engineers, 11 Upper Belgrave Street, SW1. Wed., 17 Feb., 6 p.m.*

Royal Aeronautical Society
LONDON
"Missile Control Problems," by D. Best. Astronautics and Guided Flight Section. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 18 Feb., 6 p.m.*

Society of Instrument Technology
BRISTOL
"Transducers," by R. Russ. Bristol Section. Department of Physics, University of Bristol, Royal Fort, Bristol 8. Thurs., 18 Feb., 7.30 p.m.
NEWCASTLE UPON TYNE
"Electronic Control of Water-Tube Boilers," by D. Watkins. Newcastle Section. Roadway House, Oxford Street, Newcastle upon Tyne. Wed., 17 Feb., 7 p.m.

Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institute of Welding, 54 Princes Gate, Exhibition Road, London, SW7. (KNIghtsbridge 8556)
Institution of British Agricultural Engineers, 6 Queen Street, London, WC1. (TERminus 0140)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

Collapse Behaviour of a Bolted Frame

Bolted joints of a simple pattern, described here, allow the structure to develop the ultimate load capacity predicted by established plastic theory.

By T. M. Charlton

Engineering Laboratory, Cambridge University

The design of full-strength rigid joints has an important influence upon the economics of steel structures, and the design of bolted joints to satisfy these requirements, having regard to the use of the plastic theory for the design of such structures, is being investigated in the Engineering Laboratory of the University of Cambridge. As a contribution to this work and also to try out new laboratory facilities, it was decided to carry out a test to collapse on a full-scale portal structure with a simple kind of bolted joint designed to transmit without significant distortion the full plastic moment of the members.

The structure consisted of two symmetrical pitched-roof portals having a span of 16 ft, a height to eaves of 8 ft and a rafter slope of 22½° to the horizontal, and made of 5 in by 3 in RSJs; these two portals were braced together at a distance of 12 ft by purlins of 3 in by 1½ in RSJs, fixed by welding. The feet of the stanchions were profile-welded to stiffened baseplates which were bolted to the concrete floor in order to approximate to encastré conditions. The general arrangement of the structure (after loading) and the testing gear is shown in Fig. 1. Equal concentrated loads were applied simultaneously to the centre of each rafter by means of hydraulic jacks operating through linkages. Deflections were measured as the loading increased and yielding was detected at the centres of the rafters, stanchion feet and in the neighbourhood of joints by observing the cracking of resin coatings.

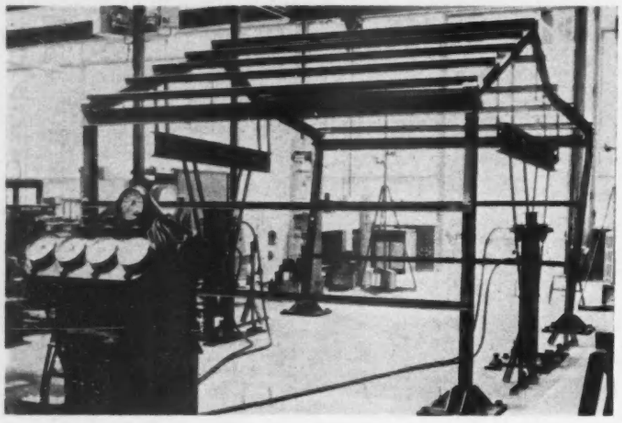


Fig. 1 (left) The laboratory arrangements, showing the frame after loading to collapse which came about with the formation of a number of plastic hinges.

Fig. 2 (right) A typical bolted eaves joint after collapse. The cracked resin coating indicates the region of plastic distortion that forms the "hinge."

Fig. 3 (below) Load-deflection characteristics of the structure. Until yielding occurred a linear relationship held good.

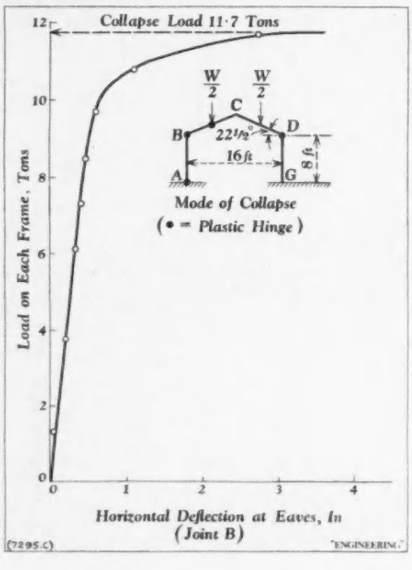
The joints consisted of ¾ in plates, flame-cut from unlaminated stock and drilled, profile-welded to the ends of members (such that the member section was reproduced in weld-metal) and bolted together by ¾ in diameter BSF high-tensile steel bolts. Clearance holes were provided for the bolts for the sake of easy erection of the structure. Details of the joints are shown in Fig. 2.

The thickness of the plates was decided somewhat arbitrarily: it was considered that ¾ in plate would be sufficient to enable the load to be transmitted to the bolts without eccentricity caused by local distortion, having regard to the size of the joints. The bolt size and material was chosen on the basis of transmission of the full plastic moment of the members of 107 ton-in (determined by tests) and also compactness of the joints. Thus, assuming there would be no contribution by the bolts on the neutral axis to the strength of the joints in bending, the load per bolt in tension due to a bending moment of 107 ton-inat a joint would be approximately 6·7 tons with the bolt spacing adopted.

As none of the joints would be subjected to appreciable shear loading under the chosen conditions, the erectors were instructed that the bolts should be nipped just tight with a standard ¾ in spanner. The stress in a bolt on the "tension side" would thus increase as the structure was loaded, reaching a maximum of not more than 27 tons per sq. in when the full plastic moment was applied at a joint. This procedure avoided the complication of correctly pretensioning the bolts. Had shear loading been significant, instead of pretensioning the bolts, caps could have been welded to the plates to carry the shear loading.

Among the features of pretensioning bolts is the increased joint stiffness to deformation in bending. In fact, if the joint plates were rigid to direct compression, the tension in the bolts would remain constant until the bending moment applied to the joint was large enough to reduce the contact force between the plates on the tension side of the joint to zero. For a bending moment greater than this, the joint would tend to open with consequent increase in tension in the bolts resisting this deformation. When there is negligible pretensioning of the bolts, as in the joints of the frame tested, loading of a joint is accompanied by some opening due to the extension of bolts in tension. Such deformation was not considered to be important in this instance, however.

During the test, the load-deflection characteristics of the structure were linear and generally in accordance with predictions based on elastic behaviour, until the load on each frame was nearly 7·5 tons, as shown in Fig. 3, when yielding at the tops of the stanchions was observed. Thereafter plastic hinges began to form at the eaves, at load points in the rafters and at the stanchion feet, and it seemed as though collapse would occur symmetrically with hinges at these points. Owing, however, to the onset of lateral instability of one end of the structure (remote from the camera in Fig. 1), hinges at the load points and stanchion feet at the opposite end of the structure did not develop fully and collapse occurred unsymmetrically, as shown in Fig. 3, when the load on each frame was 11·7 tons. The loading at collapse was predicted by the elementary plastic theory to be 10·8 tons. The additional 0·9 tons per frame which was actually necessary to cause collapse was ascribed to strain-hardening at the plastic hinges. It will be noted that the onset of instability was too late to upset the predictions based on the plastic theory.



The joints behaved ideally and showed no sign of significant opening or distortion, as can be seen in Fig. 2, which shows the eaves joint at a typical plastic hinge (point D in Fig. 3). It would seem therefore, that bolted joints of this kind can be used with confidence for simple frames designed on the basis of ultimate load-carrying capacity, provided of course that provision for shear loading is made where necessary, as indicated above.

The work described in this article was carried out with the support of the British Welding Research Association as part of a general programme of research into the behaviour of steel structures, under the direction of Professor J. F. Baker, F.R.S.

Aggregate Quality and Granulator Performance

It is the performance of the granulator or final-stage crusher that determines the shape and grading of the product from a plant producing road aggregates. Road Research paper No. 44, entitled *A Study of the Granulators Used in the Production of Roadmaking Aggregates*, summarises an extensive study of ten granulators of four main types—jaw, cone, impact and rolls—when used on twelve different types of rock to produce stone of ¾ in and under.

Among the conclusions are that the smaller sizes in any given grading generally had a poorer shape than the larger sizes, but that the size of chipping present in the greatest proportion generally had the best shape. In respect of the shape of the product only, an order of merit was obtained for the different types of granulator as follows: impact breaker with unrestricted outlet, impact breaker with restricted outlet, jaw granulator, crushing rolls, and finally the cone granulator. It was also noted that the stronger and finer grained rocks tended to give a poorer shaped product. The machines could all be controlled to produce a given maximum size of chipping or a certain maximum proportion of a given size of chipping; reducing the throughput cut down the proportion of fines produced.

There was little difference between the energy consumptions of the different machines, though the impact breakers tended to take least power. A water-saturated feed, however, tended to double the power consumption.

The report (*5s 6d*) is published for the Road Research Laboratory by the Stationery Office.

Canadians See British Concrete Work

A party of over 70 Canadian engineers and architects has recently been touring construction sites in and around the London area to learn something of the techniques of reinforced and prestressed concrete that have been developed in this country of recent years. Particularly were the party interested in precasting methods which could be used to overcome difficulties of concreting in conditions of extreme cold.

Hitherto concrete, either reinforced or prestressed, has not been an economic proposition with respect to steel in Canada, but members of the party expressed themselves confident that the use of concrete there would grow in the near future. This would seem to be in contrast with the position here in Britain, where steel looks like regaining the ground lost to concrete for structural frames.

The programme followed by the Canadians was largely arranged by the Cement and Concrete Association and included lectures and demonstrations by leading British engineers, and among the visits was one to the Association's research laboratories at Wexham Springs which members of the party later described as better than anything similar on their side of the Atlantic.

Precasting to Overcome Winter Concreting

The importance of precasting to the Canadians is noted in a report just issued by the Division of Building Research of the Canadian National Research Council in Ottawa. The report is entitled *Precast Concrete for Winter Building* and costs 10 cents. Note is taken of experience gained both in this country and on the Continent, particularly Russia, where precast concrete is being used almost exclusively for building.

Four types of joints are recognised: welded reinforcement, rigid metal, prestressed and cast joints. The welded joint is made by welding ends of the reinforcing bars that have been left exposed when casting. Rigid metal joints are made by casting short lengths of structural steel into the ends of the concrete members; and the joint is then made by bolting, riveting or welding the connectors.

Prestressed joints are made by the local use of prestressing wires which are anchored across the two units and this is suggested as the best ends of the members with reinforced concrete form of joint. Cast joints involve splicing the ends of the members with reinforced concrete which is cast in place.

Experimental Tubes in London

Contracts for the construction of two experimental lengths of "tube" railway tunnel have been placed by the London Transport Executive. The work is designed to give up-to-date information on the cost of materials and tunnelling methods. Both lengths are to have twin bores and will be on the alignment of the Victoria line, the new underground railway that is proposed for London.

It is now 50 years since a tube railway was last driven through the centre of London when all the tunnels were lined with cast iron segments; since the end of the Second World War the eastern extension to the Central Line has been constructed with the extensive use of reinforced concrete segments that were made to a pattern closely resembling the conventional iron segment. Even more recently the new tunnels at Potters Bar on the Eastern Region of British Railways have been lined with segments that were unreinforced, and so shaped that they required no grouting after erection. At Potters Bar, too, better methods of getting the spoil away from the shield face were devised than were employed when even the new Central Line tunnels were driven, by making use of a conveyor belt. Doubtless such techniques will be developed still further in the trial workings now beginning.

The two contracts have been let as follows. Kinnear Moodie and Company Limited, of London, SE13, are to construct a concrete-lined tunnel from Finsbury Park to Manor House at a cost of about £191,000; and Edmund Nuttall and Sons and Company Limited, London, SW1, a tunnel lined with cast iron between Manor House and Netherton Road (Tottenham) for £209,000.

Hydroelectric Power on the Yangtze

Plans are said to be in the course of preparation for damming the River Yangtze at the foot of the mountainous area above Ichang. At this point, some 700 miles upstream from Shanghai, the river flows through the narrow Gorges. The dam would be 650 ft high and would raise the water level right back to beyond Chungking, which could then be opened to vessels of 10,000 tons. It is estimated that the generating capacity would be 25 million kW.

As a longer term project it is planned to divert the surplus waters retained in the upper reaches of the Yangtze northwards to the Inner Mongolian grasslands and the Yellow River valley. The magnitude of the scheme is fantastic: the diverted water would first have to be pumped up to the higher ground so that it could flow through a system of canals, tunnels and lakes to the arid lands 2,000 miles to the north-west. For the first seven years, it is estimated, the constructional work would require the labour of millions of people.

Facing Slabs of Concrete

A third edition of the Cement and Concrete Association's booklet *Concrete Facing Slabs* has been issued; the author is J. Gilchrist Wilson, F.R.I.B.A. Over the last few years a great variety of concrete textures and colours have been evolved and the booklet gives information on patterns and surface treatments available, also on the reinforcement required and jointing. The various ways of using the slabs are described and notes are given on the weathering properties of the different textures.

The most important use of concrete slabs is as cladding to framed structures, in which form they are the basis of a number of proprietary systems of building. The slabs may also be used as infilling panels for structures in which the frame is kept as one of the architectural features of the building. Another use is as permanent formwork which will have attractive colour and texture. Yet another application is as facing for brick, concrete blockwork and *in situ* concrete, when the design details closely follow those traditionally used for stone or slate.

Limpet Dam Aids Dock Gate Repair

A vertical limpet dam and tunnel has been erected across the lock at the entrance to the Sharpness Docks and the Gloucester and Sharpness Canal from the River Severn estuary to enable the lock cill to be replaced before new lock gates are fitted. The use of the dam and tunnel is allowing the work to be done without interfering with the passage of traffic.

Repair of a lock cill under a limpet dam.

The work is being done for the British Transport Commission by Charles Hill and Sons, Limited, of Bristol, who are also providing the new gates.

The illustration shows the tunnel section as seen from the foot of a vertical leg of the limpet dam. The cill face has been dressed to a radius of 75 ft. Granite aggregate concrete will be used to fill the chases cut in the cill. The dead weights stacked along the cill are to counter the effects of water upthrust. Fresh air is brought into the tunnel by the duct that is lying along the weights.

Plans for an Asian Highway

Construction within a period of five years of a highway from Singapore to Istanbul in Turkey, to be called the Asian Highway, has been recommended by three road conferences which met at the end of last year under the auspices of the United Nations Economic Commission for Asia and the Far East (ECAFE).

The new road would link Singapore with Bangkok, Rangoon, Dacca, Delhi, Rawalpindi, Kabul and Teheran by the most direct route. Connections would also be built with principal centres not served directly by the road. The overall distance from Singapore to Istanbul is about 8,000 miles.

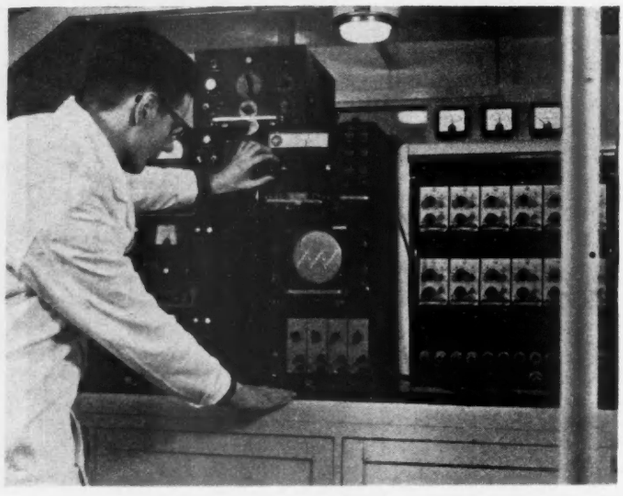
With plans now under way for the bridge over the Bosphorus (these columns last week) a trans-continental road from the Far East to western Europe by a southerly route is beginning to take shape.

Rocket Telemetry Helps a Car Under Test

Advanced techniques have been developed for transmitting metered information from space rockets back to Earth. An adaption of these techniques is now used in the development testing of cars.

By Gordon Wilkins

Telemetry techniques developed for the transmission of information from rockets and earth satellites have been adapted by Sir W. G. Armstrong Whitworth Aircraft Limited for the transmission of instrument readings from experimental motor vehicles running on the test track. Several major motor manufacturers are interested in the equipment which, it is believed, could greatly reduce the time taken to develop new models. It has already been used on an Armstrong Siddeley "Star Sapphire".



(Left) The entire telemetry transmitting equipment, through which readings from 23 different points on the car can be transmitted, is in one box on the front seat. The latest version of this equipment, which has a transistorised power unit, is considerably smaller than the one illustrated.

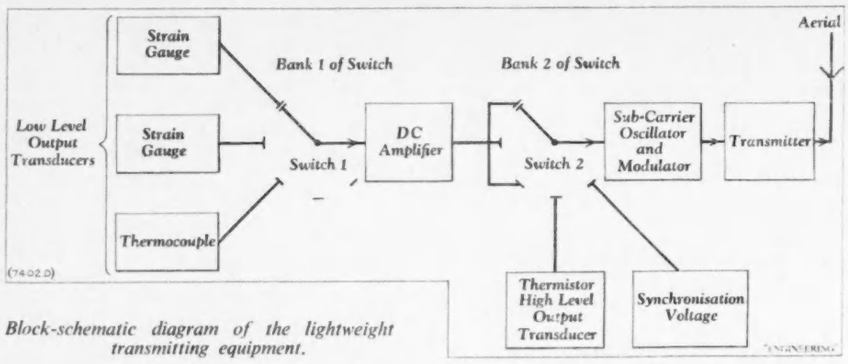
(Right) In addition to recording test results on paper, a visual indication is given on an oscilloscope. This could be invaluable in enabling the test driver to be warned if a component came dangerously close to breaking point.

Signals from thermocouples, strain gauges, force transducers and other measuring devices are fed into a d.c. amplifier and transmitted by ultra high frequency radio link to a receiver and recording unit which can be housed in the laboratory near to the test track or in a van standing at the side of the track. By using a transistorised power pack, the equipment on the car can be contained in a case about 7½ in by 12 in by 15 in and weighing less than 20 lb; only a small blade aerial is required on the roof of the car. Transmitting on a low power of only one watt, the practical range is up to four miles, sufficient for most test track work, but it can be increased if necessary. The total drain on the vehicle's battery is only about 10 amps. Hills up to about 800 ft high on the test circuit present no serious obstacle.

Such light and compact equipment obviously offers considerable advantages over existing apparatus. Carrying recording instruments in the car is not very satisfactory, as they are vulnerable to shock and vibration and their weight may affect performance, ride or noise level. The alternative of carrying an observer to make visual checks on the instruments makes the work slow and laborious. The radio telemetry equipment can make records from 23 instruments simultaneously, making nearly a quarter of a million recordings a minute. Some manufacturers in England and the United States have tried another method, transmitting the information from the instruments in the test car through a cable to a recording car running alongside. In this way the test car could, for example, run over a rough test track while the recording car running on a parallel smooth track recorded the behaviour of its suspension system, but the method has proved to be risky in some circumstances.

Signals received from the radio-equipped car are demultiplexed and the weaker ones are amplified. They can then be processed to show the results as pen traces on a chart or converted and passed into a computer to produce tabulated figures. At the same time an associated meter display or a cathode ray oscilloscope can be used to present a visual picture of what is happening.

Besides recording such information as engine revolutions, coolant and oil temperatures and pressures, such a system has obvious possibilities in recording the strains in the body structure or suspension and steering parts while the car is travelling over a rough test surface or during violent cornering manoeuvres. The possibility is being investigated of making a tape recording of the strain gauges which could then be played back into the control system of a test rig which would reproduce the stress pattern for endurance or destruction testing.



Block-schematic diagram of the lightweight transmitting equipment.

It will probably be possible also to produce a record of suspension behaviour for investigations into spring and damper effects, replacing much of the subjective judgment which now has to be used, but the number of samplings required to reconstruct a trace, such as a sine wave, accurately would limit the extent of the other information which could be transmitted at the same time.

Much of the equipment used is already in full production for Armstrong Whitworth Equipment and a representative set for use in vehicle testing would probably cost about £5,000. For vehicle work it is believed that analogue conversion is most suitable, so that a movement of 5 cm might for example be represented by 5V, but digital recorders have also been developed and these are the mainstay in two other fields for which Armstrong Whitworth are now developing telemetry systems: the continuous monitoring of production processes and the control of automatic machine tools. In such equipment signals from the transducers are converted from analogue into digital form by the use of a binary code, which is easily translated into pulse form. These pulses are fed to the multiplexer, while simple on-off commands are passed through a parallel-to-serial converter. Thus, thousands of commands can be put on a single wire. The multiplexer combines all the commands and signals into a single coded output which is used to modulate an ultra high frequency wave in the same way as a television transmitter functions.

At the receiving end demultiplexer separates the channels, which are then fed to a converter where the digital pulses are converted into analogue outputs which can be fed to control devices or machines. These techniques are already being developed to assist in the remote control of production processes and the control of automatic machine tool lines. In the field of vehicle development, they should eliminate some of the teething troubles which arise because tools have to be made before the prototypes have yielded all the information they might.

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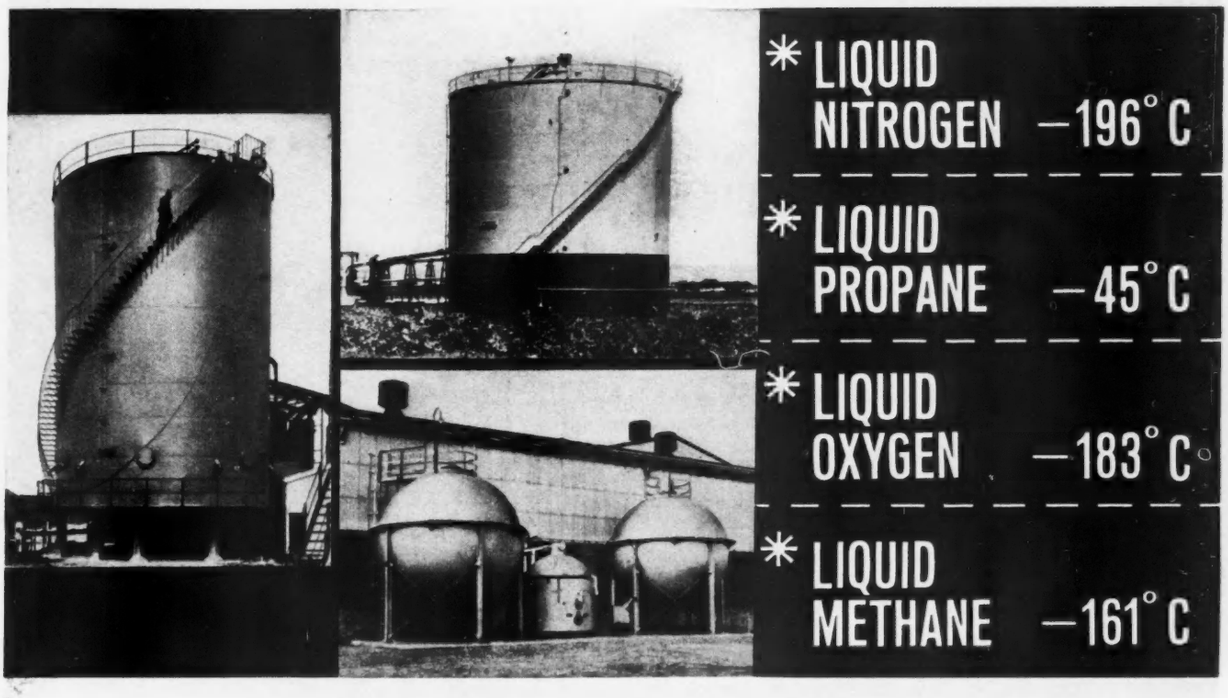

The first 1,000 ton liquid methane tank to be used in this country, insulated and double skinned storage spheres and tanks for liquid oxygen and liquid nitrogen, are examples of the experience and skill of Whessoe in designing and building large tanks or vessels for the bulk storage of liquid gases at extremely low temperatures.

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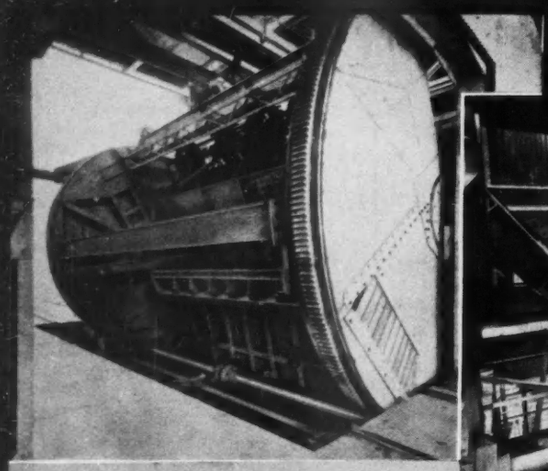
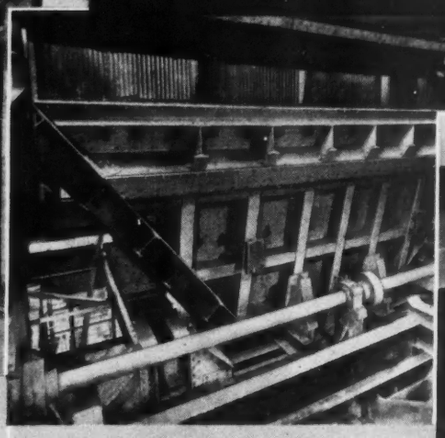
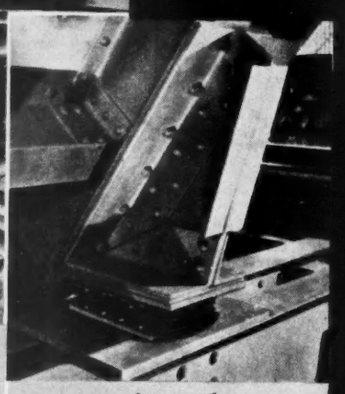


Ore is tipped out of the truck here . . .



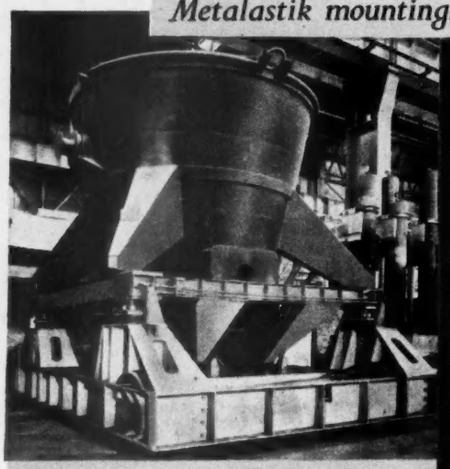
falls into this hopper . . .



mounted on 6 Metalastik mountings.

Softening the shock loads

At the Stanton Ironworks, ore is discharged from railway wagons by means of a tippler and crashes into a hopper. Normally 25-35 tons may be discharged in 30 seconds, sometimes in a steady stream but occasionally lumps of iron ore, exceeding 3½ tons fall 10-ft., resulting in impact loads which are considerable and could be damaging. Furthermore the vibration and shock impulses—unless checked—would be transmitted to adjacent buildings and plant. Accordingly the suppliers of the plant, Mitchell Engineering Ltd. called in Metalastik to reduce the harmful effects by providing mountings which normally support 11 tons each, deflecting 0.1". Under the extreme conditions already mentioned the deflection is 0.3", making a very considerable reduction in the shock effect. A similar problem arose at Samuel Fox's works in Sheffield where a magnet crane discharges large masses of scrap metal into a 60-ton scale transfer car from a considerable height. The loadcells employed had to be safeguarded from excessive shock loads in order to maintain their high accuracy indefinitely. Davy and United Instruments Limited, who engineered the loadcell weighing equipment into the installation, met the problem by incorporating Metalastik mountings as illustrated in the accompanying pictures. Whether for a small instrument, a diesel engine or a great piece of industrial plant, Metalastik mountings can always improve the conditions.



On this transfer car for weighing the charge . . .

. . . the 'loadcell' is protected by Metalastik mountings.

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Human Element

Not a Strike But A Day Off

The first concerted "industrial action" by graduate engineers and scientists over a pay claim is due to take place at Harwell, the research establishment of the Atomic Energy Authority, on 1 March.

The word strike is being studiously avoided but members of the staff, which numbers 1,500 scientists and engineers, propose to ask for a day's leave of absence on that day. 1,100 of them are members of the Institution of Professional Civil Servants but their action is unofficial and many men who are not members of the union are proposing to join in.

Mr. Stanley Mayne, secretary of the Institution, told ENGINEERING: "I cannot recall any such action by scientists and engineers. It is a measure of their dissatisfaction."

Dissatisfaction at Harwell has been building up since January 1958, when a pay claim was put in that would have given rises of between 20 and 30 per cent over a range of salaries from £400 a year up to that of a Principal Scientific Officer at £2,200 a year. A year later the Atomic Energy Authority came forward with proposals for a revised pay structure, just as the wage claim was nearing the point of going to arbitration.

Today the leaders of the Institution of Professional Civil Servants are due to meet representatives of the AEA. There is no confidence that the talks, on structure, will succeed. The union states that if the proposals of the AEA were accepted some men would be paid less.

If the talks do break down the new direction of the dispute would be towards arbitration. And the staff at Harwell, incensed a little that executive members of the Civil Service now have a wage increase while they still wait, will watch to see how the AEA responds to their polite request for a day off.

Helping Youth to Join the Nation

One of the most pertinent observations of the Albemarle report on the Youth Service in England and Wales is that young people were thought by the committee to be willing to pay more for their clubs and services than they do now.

One of the more obvious facts of the affluent society is the high spending power of the young. Before the Albemarle report introduced its particular style of commonsense and challenge no one had the insight to point out the obvious—that twopences and sixpences were out of line with the money ideas of people who buy 40*s* long-play records with the same ease that their parents put a gallon of petrol into the car.

With a youth service that touches only one young person out of three, and that often only slightly, the aim must be that of making it a useful instrument in helping as many people as possible to become conscious and willing members of the community. The unwillingness of young workers to take an interest in trade union affairs, the well known divorce between the Labour Party and the young (though the Young Conservatives occupy a partly political place in post-war society) and the disregard for any movement unconnected with music poses a problem. How to bring the first generation of those who never knew what it was not to *have it so good* into participation in something broader than the circle of friends and family?

In one way, the Youth Service has an immense opportunity. In a small modern house, its living room dominated by the television, the drive for young people to get out is tremendous. The status, setting and service of a coffee bar is comfortable but it is also stimulating and nine out of ten are too small to do anything but sit.

If the youth centres of tomorrow (not the 1970's) can be given furniture and decoration that is reasonably comparable with their commercial competitors for the young people's time; and if an enlarged number of well trained leaders are there to assist, the natural constructive energy of the 14 to 20's is more than enough to produce dazzling results.

Back to Work at BMC

Five shillings and fourpence a week more for 23 electricians' mates, instead of 10*s* 8*d* more for 11 of the 23 is one of the details of the settlement, announced by the management of the British Motor Corporation.

The two-week upheaval in the Corporation, in which the strike of 55 electricians threw more than 35,000 fellow workers out of their jobs, ended only after it had been taken up to the negotiating heights of the Ministry of Labour. Such a failure in communications, since it is nowhere alleged that the 55 were callous of the effect on those around them, or that the management were not concerned at the loss of 25,000 vehicles, is as archaic as the strike weapon has itself been called.

It may be that overseas newspaper readers do not pass their time reading of British strikes but it is not improbable that salesmen make an appropriate reference now and then to a strategically placed dealer. When millions of pounds worth of components and materials are moving on great construction lines it is an absurdity that the whole thing should be shut down over an argument which is eventually settled on lines travelled over months before.

The bonuses for two grades of electricians accepted in the latest settlement were said by the BMC to have been offered as long ago as last September.

Rail Strike Roundabout

Whether the rail strike takes place or not—and with the Transport Commission willing to pay and the majority of railmen willing to receive it will be a monument of human oddity if it does—many things will be never quite the same again.

Mr. Marples, with his gleaming reputation for publicity and for popping off to America to see how they do things over there, came with unfortunate speed up against a heavyweight in political problems such as he could never have been confronted with at the Post Office.

Mr. Sidney Greene, the secretary of the National Union of Railwaymen, spoke against the one-day token strike and had, in the end, the support of the London district council who called it, yet the underground crews struck and reduced London underground lines to a chaotic foretaste of what was threatened for 15 February. Above ground 70 per cent more cars than usual came into London, another foretaste of a slightly more distant future, and it took some people two hours more to get home at night.

For the politically minded there is also the fascinating spectacle of the Co-operative Bank agreement to lend the NUR £1 million on its securities. Not so long ago when the bus strike was slowly proving itself abortive the Transport and General Workers Union borrowed substantial amounts from other unions at very low interest rates.

The Trade Union Congress has welcomed the leaders of the three rail unions to its fine and comfortable headquarters where they found, in the words of Mr. Sidney Greene, "not a chink of light."

Herr Unsereiner

West German businessmen are launching a Work Longer Hours advertising campaign.

In magazines, newspapers and on film the German worker is to be exhorted to put in more hours and not to go on seeking for a five day week. For some time, partly because of modern equipment, partly because of shift working, the German worker has had an average working week of only 41·5 hours. In Britain it is 45·3 hours and in France 45·1.

Just as the sugar interests once personalised themselves in Mr. Cube and rammed their message home, so the German industrialists have devised a hero—Herr Unsereiner—Mr. One-of-Us—a thinking fellow who knows what is due to him but who is not easily led. Mr. One-of-Us is a symbol of far more than a longer working week.

In the United States specialised public relations agencies have been set up to project a less unfavourable image of the unions to the public. This has been necessary since the established agencies have been unwilling to prejudice their chances with the big company accounts by "associating" with union affairs. In Britain there has been talk of the desirability of the unions buying advertising space to put their case, both on union affairs and on political subjects such as nationalisation.

Industrial relations are clearly moving towards the use of the controllable public platform, by press relations and paid advertising, after years of leaving it to the industrial correspondents.

Proclamation

It may be that in the not distant future the strike-plagued British Motor Corporation will proclaim to its turbulent labour force the benefits of regular work and a steady wage packet. It would be a severe test for the skill of a Berkeley Square copy writer to get a Tees-side demarcation dispute into 200 compelling words, plus an appealing picture.

But there are good and bad ways of approaching the public. Against the pithy German trade union slogan—"On Saturdays Daddy belongs to me"—it will not help much for the Working Circle of Social Security, which the businessmen have formed, to indulge in such travesties of common sense as their warning implication that a five day week will sweep away newspapers, post, bread, buses and trains for two whole days.

First Woman Dip. Tech.

The first woman winner of the Diploma in Technology is Miss Shirley Wallis, aged 24, of Sevenoaks, Kent. For five years she has worked at the Royal Aircraft Establishment, Farnborough, where she is currently engaged on basic research in the radio department.

Since 1956 Miss Wallis has been studying at the Northampton College of Advanced Technology, London, on the college's first applied physics sandwich course.

Increasingly well recognised in industry, the Diploma is now held by 133 men and Miss Wallis. There are 3,320 students now studying for the Diploma.

In addition to its Dip. Tech. (Eng.) and plain Dip. Tech. for other technologies, the National Council for Technological Awards also awards the "Membership of the College of Technologists," its equivalent of a university doctorate in Philosophy.

Lord Hives has been succeeded as chairman of the National Council by Sir Harold Roxbee Cox.

Consultants Expanding Abroad

Seven years in Canada have equipped Mr. C. W. Bocock, a management consultant of Associated Industrial Consultants, with the experience and ability to run his firm's overseas activities from their London headquarters. He has left the company he founded in Toronto—Associated Industrial Consultants (Canada 1952) Limited—and is now back in Bush House where he has been appointed director responsible for AIC's overseas operations. He will be in touch with his old company and with the parent company's offshoots in Australia, South Africa, New Zealand, France, Holland, Germany, Italy, the United States and other countries. He told ENGINEERING last week that he foresees the possibility of providing management consultancy services in India, too. Russia and China?—they interest him.

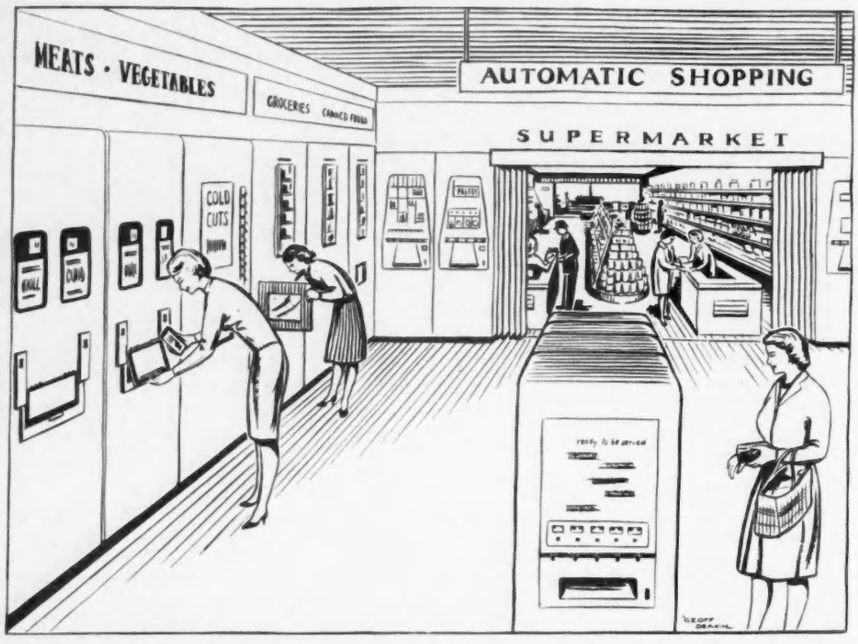
For the present, Mr. Bocock is concentrating on assistance to United Kingdom industrialists in developing trade with Europe. With the delay in development of an all-European common market, British manufacturers are setting up in Europe to establish manufacturing units there so as to avoid unfavourable influence of the common tariff on British exports.

In North America Mr. Bocock was able to assess the value of the shop training which a young engineer in England is usually given, since he could compare the finished product of that system of training with the typical American engineer who is college trained but without shop-floor experience. The comparison left him in no doubt that shop training gave an engineer a significant advantage for the rest of his career.

On the Threshold of Automatic Shops

Automatic merchandising machines on the factory floor may be the answer to one problem of three-shift working in industry. The advent of the completely automatic shop will revolutionise the distributive trades and the shopping expedition.

By J. B. W. Toole



The vending industry is becoming big business, not only for the manufacture of vending machines, components and accessories, but for the manufacturers of goods (merchandise) for sale through the machines. Although the last Board of Trade census showed just over £2,000,000 as the annual volume of sales through venders, it is estimated that the current sales of cigarettes, sweets, coffee, milk, soft drinks, tinned foods, nylons, etc., is in the neighbourhood of £10,000,000 per annum. In the USA the sales through vending machines are reported to be over £760,000,000 per annum. This month people from all over the world will be visiting the International Automatic Vending exhibition the second to be held at the New Horticultural Hall, London, to see the machines and equipment which have been developed during the past year.

Vending, the sale of goods, services or music through coin operated machines, can be segregated into two groups, refreshment vending and merchandising vending.

Refreshment vending is the sale of drinks, food and music in (i) industry—on the shop floor, in the canteen, in the office ; (ii) cafes, shops arcades, clubs, amusement centres, transit centres, or wherever the public have access.

Merchandising vending, on the other hand, is the sale of goods or services (i) from individual machines on outdoor or indoor sites in shops, garages, toilets, rest rooms, hotels, etc.; (ii) from batteries of individual machines or from automatic shops either in conjunction with self-service shops, or as complete self-contained automatic shops.

During the early stages of the vending industry's development the concentration has been on refreshment vending and the merchandising of goods through individual vending machines. Only recently has there been a concentration on the complete automatic shop and it is forecast that the distributive trades will add to the present expansion of self service shops by providing automatic shops which will be open 24 hours a day.

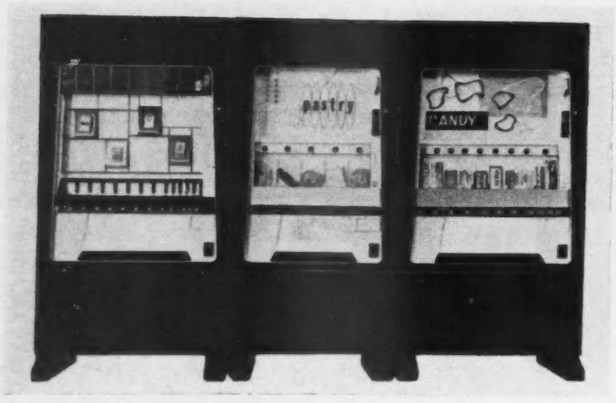
Before we review in detail the developments leading to automatic shopping let us consider the progress made in the past five years by the National Branded Goods manufacturers selling their products through single or groups of vending machines. The mainstay of merchandise vending has been the sale of cigarettes either through machines supplied to shopkeepers by the tobacco companies or through machines purchased and operated by individual operators. The number of cigarette machines in the country runs into over 100,000 and there are over 20 suppliers of machines which are made in this country or imported from the continent. America reports over 700,000 cigarette vendors in current use.

The second line of merchandise vending has been the sale of chewing gum, sweets and chocolate, nuts and raisins and the third line has been the sale of sanitary or "ethical" products. There has also been the sale of postage stamps through vending machines by the Post Office. More recently the Milk Marketing Board has been encouraging the sale of milk in bottles or cartons through vending machines and there are now over 2,000 milk venders in operation in Britain.

These basic lines of merchandise have been supported by vending machines selling nylons, books, newspapers, magazines, postal orders, insurance, ball-point pens, razor blades, and bread, but in most cases the operations covering these latter classes of goods have been small and of a trial nature, or for field testing. Automatic machines have entered into quite a new field with the installation in Pairs of a machine to sell coal (Fr. 100 for a 7½ kilo paper sack) and one in England that dispenses paraffin (bring your own can).

COIN OPERATED SHOPPING

The need for automatic shops has been foreseen for some years and in this country, on the continent, and in America experimental installations for automatic coin operated shopping have been tried both by manufacturers and by the distributive trade. These installations have been as simple as groups of standard machines, such as column and compartment venders, as with the machine made by Gloster Equipment Limited illustrated below, or as complicated as complete mechanical or electrical automatic machines selling hundreds of lines of merchandise. In



Standard manually operated machines made by Gloster Equipment Company can be banked for canteen use.

Open most of the 24 hours is a Glasgow "shop" which supplies hot and cold drinks as well as food.

many cases the installations were only in use for limited periods to enable an assessment of the public reaction to automatic shopping to be made.

Would the public use the venders when they cannot handle or feel the goods, what goods would they buy through the machines, did the machines need to be available for 24 hours a day? The answers to these and many other questions (unfair trading, town and country planning, rating, etc.) are being sought. Some of the installations worth noting are:—

J. L. Hudson Sales Mart.—This experiment inside an American department store was discontinued due to poor sales per square foot of floor area occupied by the machine.

Wm. Filene's U-Serv-U Centre.—This installation was set up in a large American bus terminal to sell goods normally sold in department stores.

Roberge Automatic Grocery Store. In 1954, after 5 years development Mr. Louis Roberge of USA produced a prototype automatic food shop. The dimensions of each unit were 12 ft by 14 ft by 8 ft. The units were refrigerated and consisted of a series of conveyor belts with a lift and drop package dispensing mechanism.

Independent Grocers Alliance "Elmer." In 1956 the Alliance of USA introduced an electronic version of the unsuccessful "Keedoozle" mechanical shopping system. Each customer is given a "key," hand-sized, containing an electronic recorder. The "key" is pushed into a slot in a display case and records the customer's selection of goods. On completing shopping the "key" is taken to a cash desk (checkout point) and the goods selected are brought by conveyor to this point ready for the customer to take home.

Skillman Electric Merchandiser. The Skillman Hiram originally called the Elmer was developed in 1954 and served up to 25 lines of merchandise. A modification of the original machines can be seen on the London main line railway stations operated by the British Automatic Company for the sale of light refreshments.

Colonial Stores, USA. This large USA food chain experimented with a battery of special purpose multi-selection venders made by Rowe and Lehigh. The refrigerated Rowe venders dispensed meat, milk and eggs. The conveyor belt Lehigh venders dispensed canned foods, bread, coffee and pastries.

Window Shops. In London and Birmingham a number of shop windows have been converted for selling goods automatically using the German "Vitrinomat" column drawer operated vender. The principal conversions are for dairies, cigarette and sweet shops, and the goods can be seen through the glass window.

Dumb Post Office. In France a portable structure containing postage stamp and postal order venders, telephones and post boxes has been developed.

Grand Union Nite and Day Automatic Supermarkets. This American supermarket chain introduced a battery of standard vending machines selling 58 different items of merchandise outside one of their stores. The battery of machines is arranged facing the pavement, and were installed to give experience of this type of automatic service.

Scotland's Autosnax. Mr. Joseph Woolfson director of Philip Woolfson, has installed in Trongate, Glasgow, a German automatic shop installation shown in the illustration. This contains hot and cold drink venders as well as compartment and column venders for merchandise. The shop is provided with a metal grill, which is drawn across during the few hours the streets are not in use.

Coin Operated Launderette. James Armstrong have introduced coin operated launderettes as competitors to the currently accepted managed launderettes. In the USA there are great numbers of these automatic service shops and no doubt their use will extend in great numbers in this country, now that a start has been made.

Express Dairies. Using Wittenberg compartment venders, Seitz shop windows, and National Gloster and Vendo milk venders the Express Dairies have provided in London an after-hours service for milk, butter, bacon, eggs and other goods. The venders are either located on the forecourt of the dairies or built into the shop fronts.

It should be noted that on the continent of Europe the design of special automatic shops has not progressed, the concentration having been on massed or banked individual vending machines built in or forming the front of the shop. Some stores report that one third of their shop sales are through this standard type of machine.

The competitive impact of the giant distributive chains of grocery and other shops has alerted the individual traders on both sides of the Atlantic, and in America the individual traders are combining to explore new methods of distribution. In this country the distributive trades expect a great increase in costs due to the demand for shorter hours and higher wages. Further competition is likely from industry which expects to obtain higher productivity by two and three shift working but in consequence has a shopping problem for its shift workers. As a result some factories are considering the installation of automatic shops for basic requirements as an added inducement for employee recruitment.

The retail distributor hopes that by making all or part of his merchandise saleable through automatic venders he will resolve or combat some if not all of these problems of cost, hours of work, and competition.

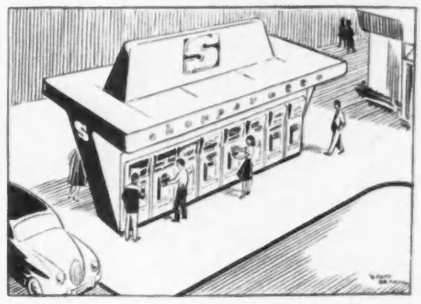
The automatic shop has great advantages to shopkeepers, shop assistants, as well as the customer: shopping takes place all round the clock; pilferage is controllable; stock is controlled; it is a cash trade; it is a convenience to the shopper; labour and cost is saved; it frees the shop assistant for selling those goods

Coal seems an unlikely item for an automatic machine, but one is now working in Paris.

requiring size, and selection, and personal service. To the manufacturer of goods the automatic shop increases the number of outlets for his goods and has distinct advertising value.

Design and production engineers have plenty of opportunity to develop the type of vender required by the retail distributor who is going to ask for certain fundamental requirements to be satisfied before he invests heavily in this new style merchandising. These requirements are: reliability; ease of use by the customer; ease of loading, preferably from the rear; adaptability to package size; change giving, not forgetting note changing; attractiveness or good styling.

In some cases auxiliary services will be needed, such as the dispensing of insulated bags for quick frozen foods, or the dispensing of a leaflet or discount (bonus) stamps. The refrigeration



An automatic shop, with only a canopy covering, built on a small island site.

engineer will be called on to provide the right temperature within the vender particularly in certain climates, and for foodstuffs.

The venders will not only be built as complete shops or as part of shops, but may be located as outdoor units on housing estates, in petrol filling stations, on beaches, and public places generally. A sketch of an island site devised by Joseph Sankey and Sons is illustrated on this page. The ability to adapt the vendor to such locations will open up many new sales outlets and greatly as st the public particularly in districts where shops are in the minority.

In addition to the grouping of standard venders using such machines as the Vendol, Wistoft, Wittenberg and the Weigandt, a number of companies are introducing complete automatic shops, the principal ones to date being two.

Electroshops. This company, associated with the C. F. Taylor Group, are advertising an improved version of the Skillman automatic shop, serving 24 lines per unit. This machine has a new version of the credit totalling coin control. The company reports that they have taken a large order for these machines from Ghana. In this vender the goods are held on conveyor belts which "inch" forward from impulses received from the customer selection button. The credit device records the amount of money inserted into the vender and subtracts the value of purchases made showing the balance to use up or receive in change. The venders can be refrigerated for selling butter and similar products.

Solartron are working with John Brown and Company to develop a card operated automatic shop, the developments being licenced by Gumpertz of the USA. In America an automatic shop is being tried out by a Supermarket chain but the principle on which the machine works has not been reported in detail.

The early automatic shops will need to be designed to fit into existing premises, but in due course premises will be designed around the venders or even the premises will be designed as a vender. With the aid of electronics we can visualise a chain of automatic shops, controlled from a central point. In each shop the coin mechanisms will be wired to a central control panel, and these control panels will be linked (by radio) to the main depot or headquarters. The rate of money taking will be collated from all shops at the same time at the one point. The central control will also show shortages when there is a heavy run on a particular type of commodity and breakdowns will be reported.

Travelling vans, radio controlled, will be used for maintenance and the shortages will be replenished by special vans which will draw up to the kerb and off-load over the heads of the people on the pavement. There will be recorders for recording incidents and to hear customer complaints. The customer just presses a button and speaks his complaint. From the central control closed-circuit television will permit viewing of what is happening in each premises. At rush hours an attendent would be in each shop to help customers and to clear problems. There would be a set time for exchange of goods or for personal handling of complaints.

FOOT PUMP

For Heavy Lubricants

FOR handling very heavy lubricants the Hercules foot-operated pump has been developed.

Pressures up to 15,000 lb per sq. in can be produced by normal foot application and the pump is capable of working with bitumastic materials such as Shell Cardium C or D compound, or Mobil Dorcia 150. At the top of the pump is a handwheel that is screwed down at intervals during operation (usually after every 20 to 40 applications) to ensure that the lubricant is forced down into the pressure chamber of the pump. The output per stroke varies slightly with the type of grease in use, but for a grease with a penetration value of 250 (cone test) it is 2·3 gm per stroke.

The high pressures developed make the pump suitable for use on long lubricating lines and can also be used to clear blockages. With positive dividers the pump can act as a master to provide a bridge between grease gun and nipple lubrication on the one hand and fully centralised systems on the other. The

pump weighs just under 50 lb and is mounted on two wheels for transport. *Centralube Limited, Eley Estate, Edmonton, London, N18.*

LAPPING MACHINE

Optical Flatness

CLAIMS for the Mark 15A lapping machine are that it combines large capacity with compactness and neat appearance. It will produce surfaces to optical flatness.

The machine is a completely self-contained unit usable with most materials. The 15 in diameter lapping plate affords large capacity and is equipped with three wear rings. As an example of the capacity, 66 components of 1 in diameter can be lapped at the same time. The maximum diameter of components that can be handled is 5½ in.

An automatic flatness control device maintains the lapping plate truly flat at all times so that the machine can be operated by unskilled personnel. A timing device is fitted which can be preset to any interval (in the standard model the range is up to 60 minutes) at the end of which period the machine is automatically switched off. Coloured warning lights indicate when the machine is in operation.

The maximum overall dimensions of

the machine are 32 in by 22 in by 20 in and it is intended for bench mounting. Anti-vibration pads are incorporated so that there is said to be no need to bolt it down.

The controls are arranged on a sloping panel at the left. Materials that can be machined include plastics, light alloys, ceramics, and ferrous metals. Low cost is another claim for the machine. *Flexibox Limited, Nash Road, Trafford Park, Manchester 17.*

DIAL THERMOMETER

Projecting Stem

LATEST addition to the Clyde range of industrial thermometers is the "2·5 CB" with the stem projecting from the back.

The dial is 2½ in diameter and is operated by a bi-metal element. The Easiread scales are used and may be graduated from 40 to 240° F or from 0 to 300° F or the equivalent ranges in Centigrade divisions. The calibrations are accurate throughout the full range.

The dial has a hexagonal nut fixing at the back with the pocket extending a further 2½ in beyond the nut itself. The pocket is detachable by freeing a spring clip. The standard fitting is screwed ½ in British standard pipe thread.

The case is robust and as no glass is used in the construction the unit is capable of withstanding more minor shocks in service than models incorporating glass members. The instrument is reasonably priced. *Buchanan Brothers Limited, Clyde Instrument Works, Commerce Street, Glasgow, C5.*

VIBRATING TABLE

Compacting Containers

ORIGINALLY developed for compacting concrete, Sinex vibrating tables have been adapted for compacting the contents of paper bags and sacks.

By compacting the contents, the sacks occupy less space for transport and storage. As much as 20 per cent can be saved in some instances. The sacks are carried on a rubber belt which passes over the table; the vibrating motion reduces friction almost to zero so that there is no wear on the belt. As there is no pressure applied, the contents are not crushed by the process.

Tables are made in a range of sizes from 12 in square to 6 ft by 4 ft. The larger sizes are more applicable to concrete work, and will carry loads up to 15 cwt. Vibration frequency is about 3,000 pulses per minute supplied by a 500W rotating electrical vibrator. Rubber mountings are employed and all welds are specially made to withstand the stresses. *Sinex Engineering Company Limited, Central Way, North Feltham Trading Estate, Feltham, Middlesex.*

ADMITTANCE BRIDGE

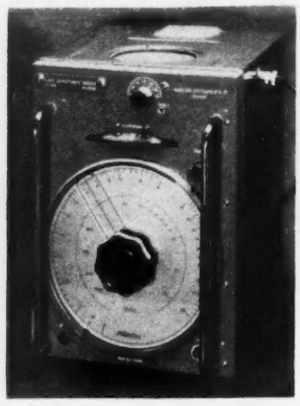
Balance System

TYPE TF978 is a new admittance bridge which incorporates a high stability servo controlled conductance balance system.

The instrument is particularly suitable for measurements on unbalanced aerial systems, coaxial transmission lines, and distributed components in general, as well as on a wide range of lumped components. Operation is in the range from 30 to 300 Mc/s. It is arranged for use with an external oscillator and detector, both of which are available as accessories. Alternatively, a conventional v.h.f. signal generator and receiver may be used.

Direct readings may be made over the conductance range from zero to 50 milliohms and capacitance from −40 to +40 $\mu\mu$F (negative capacitance is converted to inductance by formula). Balance is indicated on two wide scale dials and controls are incorporated for setting to zero.

It is claimed that residual strays are reduced to negligible proportions by the



use of a thermistor bead in place of the normal rather bulky inductance components. Thermistor conductance is controlled by means of a calibrated conductance standard in an audio frequency servo system. Dimensions are kept to a minimum. *Marconi Instruments Limited, St. Albans, Hertfordshire.*

PLASTER SPRAY

300 ft Lift

THE Stediflo Tri-Coater is an American plaster spraying equipment now available in this country.

It consists basically of a pumping unit that stands on the ground near a mixer, and a nozzle that sprays the plaster on the wall. Between is a length of pressure hose that can be 400 ft long for a lift of 30 ft or have a horizontal length of 25 ft for a lift of 300 ft.

The pumping unit with its supply hopper is mounted on a two wheel trailer and weighs about 500 lb. The approximate pumping capacity is enough to apply a ½ in cover to 150 sq. yd per hour. Power can be supplied by either a 9 h.p. petrol engine or a 5 h.p. electric motor. There are two main versions, one of which allows full control of the flow and the other control only from half to full flow.

The nozzle has a snap-on rubber tip and four sizes of orifice. Controls on the nozzle govern the operation of the pump so that the operator can make

adjustments to suit his immediate conditions. Flow and spreading rate depend to some extent on the mix used and for gypsums it is advised to use 2 in diameter hose. Light mixes can be pumped through 1½ in hose. When pumping up several floors it is recommended to use 2½ in galvanised pipe or conduit for the vertical section. It is claimed that one man can spray up to 1,200 sq. yd to a thickness of ⅜ in in 6 hours. *W. J. Roberts and Son Limited, Didsbury, Manchester 20.*

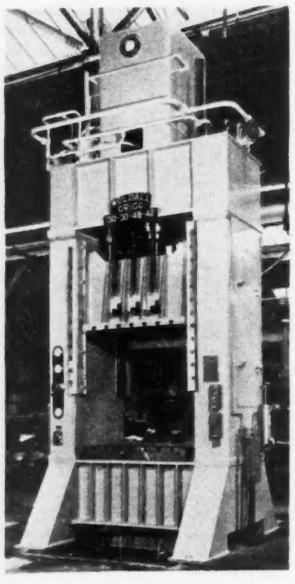
HYDRAULIC PRESS

Deep Drawing

THE Weldall deep drawing press illustrated has a capacity of 150 tons and a bolster and slide area 48 in wide and 42 in through.

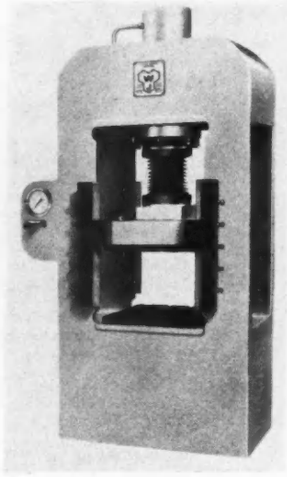
The press has a fast approach speed of 10 in per sec and a variable pressing speed of from zero to 1·3 in per sec. Operation of the press is controlled from a push button station mounted on the front of the right hand side frame and the slide can be inched down, run on single cycle automatic, or continuous cycle.

The die cushion tonnage can be varied from zero to the maximum of 25 tons on the twin hydropneumatic cushions. Two stage blank holding pressure control is fitted. The stroke controls for both the slides and the die cushions are housed in the right hand side frame. Adjustment is by the handwheels on the lead screws which control the points of slow down, reversal, and delay. The press tonnage is variable over a wide range. *Charles S. W. Grigg Limited, 65-67 Hanworth Road, Hounslow, Middlesex.*



FRAME PRESS

Up to 250 Tons Loading



THE recently introduced Prestige range of frame presses has models with loadings from 50 to 250 tons.

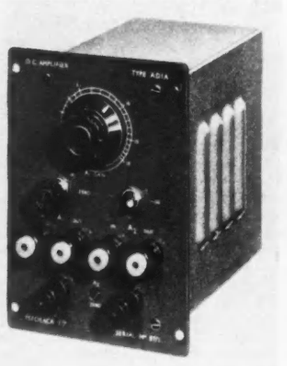
The presses are intended for bushing, bending, straightening, hot and cold forming, and cold flow forging. Power is supplied by an electric motor that drives a high speed pump through a flexible coupling. Normally the pumping equipment is built-in. All rams have power return. Control can be by fixed or pendant push button or by foot or hand lever; a calibrated pressure control valve enables the pressures to be preset.

The stroke and daylight in all models are 15 and 24 in respectively, and the table and platen vary from 24 in by 24in for the three smaller sizes to 36 in by 36 in for the two larger ones. Approach speeds vary from 112 to 60 in per minute and pressing speeds from 28·9 to 18·8 in per minute. These speeds can be varied to suit requirements.

The main frame is of welded steel construction and four machined slides engage the moving platen to ensure alignment. The platen and table have machined surfaces, and T slots are optional. *William Jones Limited, 1 Fitzroy Square, London, W1.*

D.C. AMPLIFIER

Double Unit with Variable Gain



THE type AD1A amplifier is a double unit with variable gain and a wide frequency range.

The instrument is intended primarily for experimental work on system frequency and transient response, and also as a unit for analogue computer arrangements in research and design establishments. It is flexible and adaptable and contains some built-in control facilities. The amplifier is one of a series of instruments including wave form generators and power supplies.

One of the two amplifiers in the AD1A has an operating range from d.c. to 100 kc/s (± 3 db) with a balanced input stage to reduce drift effects. The gain is continuously variable from +1 to +20 by feed back adjustment. The other section can be switched to give a gain of either −1 (d.c. to 100 kc/s) for phase reversal or −150 (over the range d.c. to 40 kc/s) for addition, integration, or function generation using external networks.

Both amplifiers have a high input impedance and low output impedance with a maximum output of ± 50 V, ± 2 mA. The two amplifiers may be used independently or connected in series to give a maximum gain of −3,000 for more precise function generation. *Feedback Limited, 1 Broadway, Crowborough, Sussex.*

DUCT FITTINGS

Formed from Sheet

THE Velflo range of circular duct fittings is made by precision dies from sheet materials; they are suitable for high velocity air systems.

The formed components are welded together to form complete assemblies. One of the most important advantages is that the passages are left smooth and with uniform curvature so that the minimum resistance is offered to the air stream. Fibres present in the system, as for example when used for dust extraction, cannot be caught on irregularities of the surface. Uniformity of performance is a special claim of the makers.

The standard range includes 90°, 60°, 45°, and 30° bends made with 1 × D or 1½ × D throat radii, and twin bends of the same throat radii made at 90°, 60°, and 45°. The bends are hot dip galvanised as standard finish but other surface treatments can be provided, or the fittings can be left black. Non-standard assemblies can be supplied to special order. *Wilmot Breeden Limited, Amington Road, Birmingham 25.*

PLATFORM TRESTLES

Adjustable Height

MAXIMUM safety is the main claim for some adjustable platform trestles that have recently been put on the market.

All welded in steel, the trestles will stack flat in multiples. The main uprights are made of 1¼ in diameter steel tubing with 1 in diameter extending tubes, and triangular shaped legs of ¾ in diameter stock. A lower crossbar spaces the uprights and the upper crossbar on which the platform rests can be supplied in either 1½ in diameter tube or 2 in by 1½ in angle. At the ends of the bar are locating lugs that project upwards to prevent the planks from slipping off.

The trestles are being marketed in 11 sizes ranging from 19 in closed to 33 in extended up to 4½ ft closed to 8 ft extended. There is also a choice of widths ranging from the narrowest that will take three planks, to the widest that will accommodate five planks. *General Trade Equipment Limited, 89-92 Seymour Place, London, W1.*

ANALOGUE COMPUTER

Central Patching

THE Elliott G-PAC Mk 2 analogue computer has been developed to combine the convenience of the centrally patched computer with the flexibility of direct patching between units.

The machine is based on the modular principle with plug-in brick units. The basic module is a double cabinet structure with a full width control desk and is mounted on a plinth trolley. Additional cabinets can be added on either side. The operation is controlled by push buttons with mode indicator lamps.

The centre accommodates 10 summing amplifiers; 10 summing integrators; 40 10-turn helical potentiometers for coefficient and initial setting: three servo multipliers, each of which can have up to five function potentiometers; and five Mk I amplifier positions which can be used to accommodate any standard non-linear unit, or special unit for a particular problem. The centre also contains the central patch panel, the control and monitoring facilities, and the reference supplies. Provision is made for the interconnection and slave operation of a second computer. *Panellit Limited, 70 Dudden Hill Lane, Willesden, London, NW10.*

DUMPER

Concrete-carrying Body

THE Muir Hill 10B hydraulic dumper has now been fitted with a new concrete carrying body.

The unit has been designed for the particular purpose of carrying concrete between the batching plant and the site; it is said to offer special advantages for feeding pavers on road construction projects where the hauling distance is often too short to warrant the use of agitators or of mobile mixing plant.

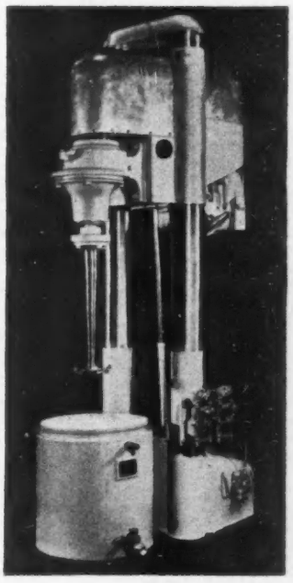
The new body has a liquid carrying capacity of 2 cu. yards when operating on a gradient of 1 in 10. This size renders it suitable for use with standard continuous mixers of 1 cu. yard capacity.

Construction of the machine has been so arranged as to provide a tipping height of 4 ft 6 in under the lip of the body; this height is suitable for discharging the concrete into standard 1 cu. yard and 2 cu. yard Tremie buckets and pump hoppers. The tipping angle between the floor and the body mouth at the maximum degree of tip is 56°.

A vibrator unit may if desired be fitted to the under side of the body mouth to facilitate slow discharge of the contents with the body unit only partially tipped. For direct placing, a chute may be fitted to allow the concrete to be discharged at ground level. *E. Boydell and Company Limited, Old Trafford, Manchester.*

DISPERSER

For Viscous Solutions



TO be shown at the twelfth technical exhibition of the Oil and Colour Chemists Association is a disperser for putting finely divided solids into viscous solutions.

Rapid operation is one of the claims for this machine which can be used for solutions of resin varnishes, lacquers, and other coating materials. It is designed to combine the advantages of high power input with a high speed impeller. It has a range of speeds to suit the particular dispersion being made, adjustable by a handwheel up to 50 r.p.m. Power is supplied from a flameproof motor.

The head can be power raised and lowered into the movable container and the impeller is easy to clean, which is an advantage. Containers can be used with capacities ranging from 25 to 150 gallons. The design of the impeller and the ability to choose the speed enable the dispersion to be made very rapidly. *Steele and Cowlishaw Limited, Cooper Street, Hanley, Stoke on Trent.*

POSITION INDICATOR

For Valves

To indicate the position of high vacuum valves, limit switch devices have been fixed to the operating air cylinder.

The illustration shows a 2½ in air cylinder mounted on an 8 in right angle high vacuum valve. At top and bottom of the air cylinder are the limit switch assemblies that contain microswitches with one normally open and one normally closed contacts. Plungers from the microswitches project into the ends of the air cylinder and engage with a shell extension of the air piston. As the air piston moves to one end, the tapered end of the shell pushes the plunger outwards and so operates the microswitch. Thus remote indication of the plunger position, and therefore of the valve itself, is given. They can also be used for sequence and interlocking.

Four standard sizes are available for use with 1½, 2½, 3, and 4 in Martonair cylinders. Contact ratings are 10A at 250V. *Vacuum Research (Cambridge) Limited, Quayside, Bridge Street, Cambridge.*

HYSTERESIS MOTOR

1 1/16 in Diameter

The new size 11 hysteresis motor has a mechanical output of 8W for an outside diameter of 1 1/16 in.

The motor will start under full load and has completely synchronous operation. The body length is only 1·58 in. All motors can be used on either 200V, or 115V 3 phase 400 cycles supplies. A 50 cycle version is under development.

When connected for 3 phase 4 poles, the motor has a synchronous speed of 12,000 r.p.m. and a maximum synchronous torque of 60 gm-cm. The weight is 4½ oz. Efficiency is 50 per cent and the temperature rise is 50° C. Moment of inertia is 2·9 gm-cm². For 200V input the stall current is 145mA and the no-load current 98mA.

The 2-phase 6 pole version that is also obtainable has a slightly reduced performance on 115V. The speed is 8,000 r.p.m., maximum synchronous torque 35 gm-cm and the no-load current 123mA. Weight and dimensions are the same. *Smiths Aviation Division, Livingstone College, Leyton, London, E10.*

RUBBER CONDUIT

Wide Range of Cable Size

The non-trip rubber conduit for protecting cables laid on the floor is now being made in an increased variety of sizes.

The rubber strip forming the conduit is tapered from the edges over the round of the cable so that vehicles can run over it without damage.

Standard sizes now available range from the "office" section that will take 2, 3 or 4 strand cables in a rectangular tunnel measuring 5/16 in by 5/16 in (overall dimensions of the conduit are 2 1/16 in across the base by 7/16 in high) to an industrial size that will take a single ½ in diameter cable and measures 4½ in across the base by ¾ in high. A third version will take two ⅜ in diameter cables in separate tunnels and measures 3½ in wide by ⅝ in high. All industrial types are made in oil resistant material. Facilities are available for making conduit up to 10 in wide at the base to take 2 in diameter cable. *Vulcascot (Great Britain) Limited, 87-89 Abbey Road, London, NW8.*

REAMER

With Replaceable Blades

Now available in this country is the German Mapal reamer in which the blades are replaceable.

A special claim for the tool is that it can eliminate an intermediate operation between drilling and reaming because its action is a combination of single point cutting and burnishing. High cutting speeds are not necessary but good lubrication is essential.

Since the blades can be removed from the reamer body, some saving in regrinding is effected; a small master fixture holds the blades during the operation. Through or blind holes can be machined, and guide bushes and jigs are largely eliminated. It is stated that hole size is consistently maintained and when the replaceable blade is worn out new ones can be fitted.

The reamers are set initially to produce holes within the BS and International Standard limits and are also available in the Newall range of hole sizes. *Monks and Crane Limited, Garretts Green Lane, Birmingham 33.*

RADIATION MONITOR

Background Levels

A lightweight portable monitor has been introduced for measuring background radiation.

The instrument, known as the type PNI 1072, has been designed to fill the need for an accurate means of measuring any background activity, both quickly and easily.

The method of detection employed in this case is that of a built-in halogen-quenched Geiger Müller tube with the measurement being made on a transistor ratemeter. In this way a direct reading of the dose rate is given on a 2½ in scale moving-coil meter. A socket is provided for connecting a recorder and the controls include a battery check position.

The instrument covers a range of radiation from zero to 3 milliroentgens per hour on a two decade quasi-logarithmic scale with a minimum scale calibration of 30 microroentgens per hour. Power for the instrument is supplied by a 9 V dry battery. The weight complete with the battery is only 8 lb. *Plessey Nucleonics Limited, Weedon Road, Northampton.*

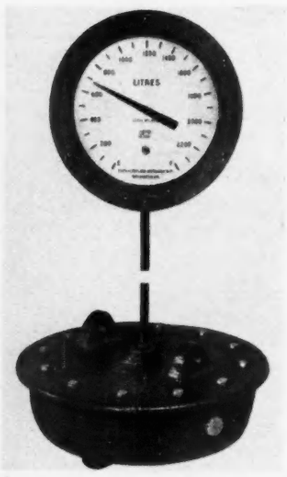
TANK GAUGE

Pressure Bulb Type

A hydrostatic tank contents gauge now on the market measures the head of liquid in non-pressurised tanks.

The gauge is supplied in two units, the indicator and the transmitter. Connection is by air line and the distance between them may be as much as 250 ft. The indicator is made in four sizes with dials from 4 in to 12 in diameter and can be calibrated to show either the depth of the liquid or the quantity.

The transmitter has a synthetic rubber diaphragm between two chambers, the lower of which is open to the liquid in the tank. The hydrostatic head of the liquid is transmitted through a small bore copper or nylon air line to the indicator. The transmitter unit weighs 12 lb and measures 8¾ in diameter; it can be mounted either externally or internally in the tank. The unit is normally made of cast iron and can be finished in different ways to suit the liquid in question. The maximum recommended working temperature of the transmitter is 65° C. Changes in atmospheric temperature and pressure have little effect on the accuracy. *Firth Cleveland Instruments Limited, Stornoway House, St. James's, London, SW1.*



METAL SPRAY

Automatic Control

The type C control system illustrated is a fully automatic unit for heavy duty or production metal spraying.

The control unit is built on the module system to give maximum flexibility in degree of control required. The basic unit consists of electrically operated on-off inlet air, oxygen, and gas valves. Permanent connection is made to these valves from the factory supply and gauges are fitted to show the supply pressure. There is a ventilating fan arranged to start when the fuel gas is supplied. The operating controls are interlocked with the air pressure. Flame failure is also guarded against. Remote control can be incorporated for use when two or more machines are operated from one panel.

When the controls are set, depressing the metallising button starts the lighting and operating sequence. The speed of the wire is maintained constant by the control unit and has a wide range. Pressing an "idle" button stops the wire and leaves only a pilot flame so that the process can be restarted simply by again pressing the metallising button. Failure of the electric power, compressed air, gas supply, wire feed, dust extraction, or failure of the mechanical handling of the component, can shut down the plant. *Metallizing Equipment Company Limited, Chobham, Woking, Surrey.*

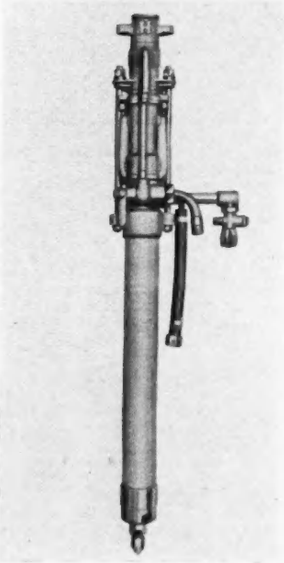
ROCK DRILL

Double Extension

Additions to the Holman range of rock drills are the Silver Three Autostopers; there are two models, one with single and the other with double extension.

The drill is developed from the Silver Three Handril and is integrally mounted on the piston of the feed cylinder giving a feed length of 31 in. Positive feed control is provided on the handle. The cylinder is 2½ in diameter and the length when fully closed is 61½ in. It weighs 86 lb.

The double extension model, illustrated, has a closed length of 51 in to enable it to work in confined spaces. It gives a feed length of 40 in. The feed is controlled to fine limits by a twist grip throttle. The two cylinder bores are 2 1/16 in and 2¼ in. Fully extended, the length is 91 in. With a collared steel chuck the weight is 98 lb. Both machines are robust in construction and have a high rate of blows. Lubrication is by line oiler. *Holman Brothers Limited, Camborne, Cornwall.*



Outsider

Some consortia are building the Generating Boards' nuclear power stations at a loss, others will be making less profit than anticipated. It is vitally important to the consortia to determine whether the high development cost of building the first stations can be recouped on subsequent contracts. There are three consortia left after the industry's reorganisation; and there are three more stations to be built: Dungeness, Sizewell and Oldbury. It is now certain that the first two will be similar to previous Calder Hall type stations, and two consortia stand a chance of halving development costs. But the fate of Oldbury, and the third consortium, are less certain.

Whither Oldbury?

Ever since the Ministry of Power gave indication that consent for the Oldbury site may soon be forthcoming, speculation has been rampant. The question is whether the Atomic Energy Authority and the Generating Board feel confident enough in the results of development testing in connection with the advanced gas cooled reactor to attempt a full scale power reactor? Or will they decide to wait, and build Oldbury along accustomed lines? Some newspapers appear to have taken it for granted that Oldbury will indeed be the first commercial application of the Authority's experience from PIPPA to the AGR, but the nuclear industry is more sceptical for a number of reasons.

Question of Timing

The experimental AGR at Windscale will come into operation early in 1961, provided everything goes according to plan. It is not unusual for the Atomic Energy Authority to jump rather than walk; it has done so with eminent success when Calder Hall was built. Similarly, the Generating Board has decided to purchase reactors of ever increasing size without waiting for the first smaller reactors to come into operation. But the size of Oldbury—1,000 MW(e)—makes for a rather long jump, particularly if it is to be the first of an entirely new reactor type. The considerable risks involved were pointed out in Power Programme Comment, Atomic Review, 9 October, 1959.

Stainless Steel or Else?

Further doubts arise from the problems of fuel element canning for an advanced gas-cooled power reactor. The Generating Board is reportedly thinking in terms of 0·015 in stainless steel. According to one estimate, the poisoning effect of the required amount of stainless steel would make the production costs of an advanced reactor higher than attainable with the latest Magnox stations. According to the estimate, the break-even point occurs if the wall thickness can be reduced to 0·007 in; that is less than half of the expected value. But the irradiation life of such weak cans is far too short for economic operation. The use of beryllium would solve the problem of neutron economy and structural strength, but beryllium appears to have fallen out of favour. Apparently results of irradiation testing, which have only recently become available, were not as encouraging as expected, and there is no indication that this stubborn but promising metal would be used in the experimental reactor at Windscale.

Mixed Station

If the above evaluation is correct, it would indicate that the problems of a commercial advanced gas-cooled reactor are still far from being solved. The purpose of the whole AGR programme is to reduce generating costs, and under the present conditions of power demand and supply there appears to be little other justification for embarking on construction prematurely. It would be a surprising move for the Generating Board to invite tenders for a reactor station of unprecedented size, novel conception and unsettled design. A wiser move would be to wait for operating experience with the Windscale AGR. Someone in the consortia has speculated that Oldbury might well be a three or four reactor station consisting of one advanced gas-cooled, and two or three conventional reactors, all feeding the same turbomachinery.

Graphite to the Rescue

There are two alternatives to stainless steel or beryllium canning. One would be impermeable graphite, with which considerable experience will become available from the Dragon and Zenith studies. But impermeable graphite still makes for a radioactive gas circuit, and once the expense of added shielding and complex maintenance is accepted, it is a pity to stop at the temperatures contemplated for advanced gas cooling. If impermeable graphite is the answer, why not wait for the high-temperature reactor? There is one other possibility which was first discussed at the Winter Meeting of the American Nuclear Society, and that is the graphite backed metallic can, which would be ideal for an intermediary between Calder Hall and the high-temperature gas-cooled reactor.

Semi-Homogeneous Fuel Element for 1,700° F

There is a range of reactor temperatures between the extremes employed in various active gas-circuit reactor proposals such as Dragon or Brown, Boveri—Krupp, and the Calder Hall type reactor, where the containment of fission products within the fuel elements is still possible, but requires unusual solutions. While the operating temperature of a true HTGCR may be around 2,700° F (1,500° C), employment of a metallic can limits the temperature to around 1,700° F (1,500° C). Hitherto fuel in the form of clad ceramic rod bundles or sintered metallic dispersions has been proposed, requiring a highly sensitive and costly reactor control system. Should the coolant circulation fail for some reason, the metallic can would melt in a matter of seconds owing to the very low thermal inertia of the elements. General Atomics first reported work on a fuel design having higher thermal inertia in connection with their marine gas cooled reactor programme (MGCR) at the Oak Ridge conference on gas-cooled power reactors in October, 1958 (Atomic Review, 18 Sept. '59). It was proposed to dilute the fuel with graphite in a homogeneous mixture. A reactor type intermediate between Calder Hall (fission products contained with the fuel) and the HTGCR (fission products contained with the core) resulted, where some of the moderator was placed inside a metallic can along with the fuel. The arrangement solved the problem of thermal inertia, but made canning extremely difficult. To keep the amount of absorbing material in the reactor reasonably low, it was necessary to contain the bulky fuel-graphite mixture in 3 to 4 in diameter cylinders. Owing to thermal cycling and large differential expansion, the cans did not stand up well to testing under reactor conditions.

Metallic Diffusion Barrier

A so-called "semi-homogeneous" fuel element, described by R. C. Howard at the ANS Winter Meeting of 1959 in paper 10-7, overcomes the structural problems while retaining the high thermal inertia of the homogeneous design. The principle is to employ "small diameter fuel bodies clad with metal cans which are backed up with massive moderator." In practice, thin metal tubes are filled with cylindrical fuel pellets and pushed inside longitudinal holes in a graphite slab such as that shown in Fig. 1. Several slabs are assembled into a box to make up the complete fuel element. The tubes fit snugly inside the holes, ensuring good thermal contact and permitting the use of very thin metal. The tubes serve only as diffusion barriers and are not required to resist the bursting pressure of gaseous fission products. In addition to higher thermal inertia and good neutron economy, secondary advantages of the design are an increase of the effective heat transfer surface by the addition of a large mass of graphite without a corresponding increase of absorbing material; and a reduction in the absolute value of differential thermal expansion between cladding, graphite and fuel which had proved troublesome in the homogeneous design. The disadvantages are that the maximum reactor temperature is reduced by the amount of temperature drop through the cladding and graphite, and the possibility of chemical reaction between cladding and its graphite support.

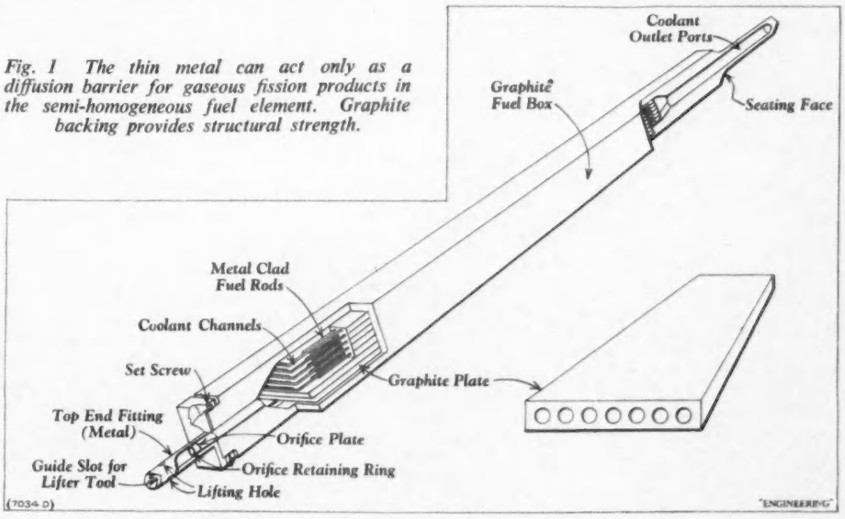


Fig. 1 The thin metal can act only as a diffusion barrier for gaseous fission products in the semi-homogeneous fuel element. Graphite backing provides structural strength.

Incompatibility at High Temperatures

Graphite-metal reactions had been investigated before the Oak Ridge conference and the results were reported at that time. High strength nickel base alloys and various stainless steels were found to carburise rapidly at 1,500° F, although not at 1,300° F. Ferritic steels and some iron-chromium-aluminium alloys did resist carburisation, but were too weak at the operating temperature to be of use. Since the Oak Ridge conference it was found that Monel and "A" nickel were the only suitable materials for operation above 1,700° F, with Monel somewhat superior because it is not subject to graphite precipitation after thermal cycling.

Results by 1961

Extensive out-of-pile testing showed that thermal and pressure cycling were not insurmountable problems, and collapse of the can from external pressure could be prevented by careful design. Rupture tests have also been performed to determine the value of graphite support. It was found that a tensile stress of 1,100 lb per sq. in was developed in the graphite surrounding the can before rupture occurred. A test element containing ¼ in diameter fuel tubes is now undergoing tests in the Hanford DR test loop with a heat flux of 100,000 Btu per hr sq. ft at 1,700° F to determine the effects of carburisation under irradiation, and the effectiveness of thin metal as a diffusion barrier.

Test results will become available by the end of the year and it is hoped that the concept's feasibility will be established. If a reactor is built using semi-homogeneous fuel elements for 1,700° F operation, it would provide an additional link in the chain of development from Calder Hall (640 to 760° F), through the advanced gas-cooled reactor (1,500° F), to the true high-temperature reactors operating above 2,500° F.

Notes and News

Britain Lagging in Radioactivity Measurement

With an eye to the increased use of radioactive materials, the European Nuclear Energy Agency (a branch of OEEC) has published a comprehensive survey of measuring and recording facilities for environmental radiation in member states. In all, there are 209 permanent recording stations in OEEC countries. Germany has the most detailed coverage with 43 stations for a land area of about 96,000 sq. miles,

while Sweden has 47 stations for 173,000 sq. miles. Rather surprisingly the United Kingdom has only seven stations for a land area of 89,000 sq. miles—and perhaps the most intensive utilisation of radioactivity in all of Europe.

Rise in Radioactivity Expected in Spring

Benefits of stopping nuclear weapon tests continue to mature as the concentration of fall-out radioactivity shows a steady decline from the maximum value recorded early in 1959. In the eastern United States, the ground level atmospheric radioactivity has dropped to one one hundredth of the value in April and March last year. During the last quarter of 1959 the pattern was similar throughout the world. Fallout collected from precipitation, on the other hand, showed a marked increase in New Zealand during the months of June to October. Present concepts of fallout deposition indicate that a seasonal rise in air concentration will occur in the northern hemisphere in the spring of 1960, followed by a decrease later during the year. The delayed effect is caused by the slower rate at which atmospheric contamination reaches the earth from higher altitudes.

Health Congress

Sir John Cockcroft will preside over the radiation section of the Royal Society of Health Congress, to be held at Torquay on 25 April. Three papers will be presented: radiation protection in the production and transport of radioisotopes; waste disposal in the use of radioisotopes; and the control of hazards in the use of luminising compounds.

Papers Invited for Hot Laboratory Conference

Last date for submitting summaries of p apers proposed for the eighth hot laboratory and equipment conference is 16 May. If accepted, the completed papers must be submitted before 1 September. The conference will coincide with the winter meeting of the American Nuclear Society, and will be held in San Francisco from 11 to 14 December, 1960. Papers are invited on all phases of hot laboratories and handling equipment for radioactive materials. Further information may be obtained from the programme chairman, J. R. Lilienthal, Post Office Box 1663, Los Alamos, New Mexico, USA.

Nuclear Superheat Demonstration

Nuclear superheat will be produced in a boiling water reactor, to be built as a joint undertaking by the USAEC and the Puerto Rico Water Resources Authority. Rating of the power reactor demonstration plant will be 16·3 MW(e), and the cost is expected to be $11 million. Preliminary feasibility studies were undertaken by the General Nuclear Engineering Corporation of Dunedin, Florida, and negotiations with the USAEC for a final design are in progress. Full-scale nuclear superheat experiments will be conducted in the Commission's Boiling Reactor Experiment Number 5. Other companies interested in the problems of nuclear superheat are Combustion Engineering and General Electric, while the Northern States Power Company of Minnesota will build and operate the Sioux Falls boiling water reactor, for which the principal contractor is Allis-Chalmers.

Details of Sioux Falls Nuclear Superheater

Official name of the nuclear superheating demonstration project at Sioux Falls will be Pathfinder Atomic Power Plant. The reactor will be a controlled-recirculation water boiler with two fuel regions. Highly enriched fuel in the centre of the core will act as the heat source for the superheater, while slightly enriched fuel will produce saturated steam in the outer zone of the core as a normal boiling water reactor. Rating of the plant will be 204 MW(t) with an electrical output of 66 MW. Plant efficiency will be almost 33 per cent, which compares with 26 per cent for Shippingport and slightly under 29 per cent for Dresden, the latter with almost three times the output of Sioux Falls.

Organic Moderated Ship Reactor from America

Although heavily committed to the pressurised-water reactor for marine or submarine propulsion, the USAEC continues to investigate the suitability of other reactor types. Atomics International has prepared a study for an organic moderated and cooled propulsion plant for a 60,000 ton tanker with a maximum speed of 18 knots. The reactor will produce 93 MW(t) with a moderator pressure of 34 lb per sq. in; inlet and outlet temperatures being 620 and 675° F (327 and 357° C). Mechanical design of the reactor vessel is remarkably similar to the Hawker Siddeley proposal, the schematic arrangement of which was shown in Atomic Review, 23 October, 1959. Main departures are that no fuel handling equipment is provided on board, and the control-rod actuating mechanism is located in a space underneath the reactor. Reactor room equipment is also similar, with two independent heat-transfer circuits located adjacent to the reactor vessel.

Process Heat for Salt-Water Conversion

A 40 MW(t) pressurised-water reactor will be constructed to produce steam at pressures ranging from 5 to 175 lb per sq. in. The process steam will be used in a salt-water conversion plant of one million gallons per day capacity using the multi-stage flash distillation process. Estimated cost of the reactor is $4 million, while the conversion plant will be about half that. The project is intended as a general evaluation test for the economics of nuclear process heat (Atomic Review, 5 February, 1960) and will be undertaken jointly by the USAEC and the US Department of the Interior.

Neutron Shield of Wood Laminate

Part of the top biological shield at Dounreay is made of laminated and densified wood blocks, covered with a cadmium sheet and encased in a sheath

Fig. 2 The high flux, low power research reactor of Nuclear Development Corporation is intended for series production.

of pvc. The material is sold under the trade name Jabroc N, and is fabricated from beechwood veneers interleaved with a film of glue and compressed under heat. The density of the finished product is 84 lb per cu. ft or more, depending on the amount of neutron absorbing material added during manufacture. Hydrogen content of the laminate is comparable to that of water, but the wooden blocks are self-supporting and need no additional containment. Boron carbide or rare earth absorber may be added uniformly distributed in the block or concentrated in a single sheet. Jabroc N is manufactured by Permali Limited, of Gloucester.

Drive to Expand Use of Radioisotopes

Manchester was the scene of a concentrated effort to spread the use of radioisotopes in industry. A team of isotope consultants form the Wantage Research Laboratories of the UKAEA has been invited by the Manchester Joint Research Council and the Chamber of Commerce to advise interested industries on applications and techniques. The visit was arranged in connection with an exhibition illustrating the industrial applications of radioisotopes.

Research Plans for Proton Synchrotron

Completion of CERN's 25 GeV proton synchrotron six months ahead of schedule caught planners of research projects off guard and no detailed plans are available at present. At a Press conference in connection with the official inauguration of the accelerator Sir John Cockcroft outlined the probable course in which investigation will proceed. Although there are no theoretical predictions concerning existance of further strange particles, the search will continue. More important will be the exploration of atomic nuclei by means of beams of very high energy (or short wavelength) mesons, to discover the interactions between subatomic particles at very close distances and high energies. With increasing energies the nature of interactions may change and there is a possibility that the predictions of quantum mechanics may break down. Sir John did not believe that construction of higher-energy accelerators would be justified before sufficient experience is gained with available machines.

Glandless Pumps for Trawsfynydd

Twenty-four glandless pump and motor units, to operate at 350 lb per sq. in pressure, will be supplied by Hayward Tyler and Company for the heat exchangers of the Trawsfynnyd power station. The order is worth £100,000.

Large Helium Find in Saskatchewan

The virtual monopoly of the United States in helium production may soon be broken as a result of large helium finds in the Swift Current region of Saskatchewan. The first find was made last year by British American Oil when drilling for natural gas. Helium content is reported to be about 2 per cent, or roughly the same as in the Texas oil fields, where most of the world's helium originates (Atomic Review 18 Sept. '59). The economics of high-temperature gas-cooled reactors is sensitive to changes in helium cost. Present prices range from $17 to $21 per thousand cu. ft.

Petten Shared by Euratom and Holland

Holland's new materials testing reactor HFR will be used jointly by Euratom and Reactor Centrum Nederland in an effort to coordinate research undertaken by European centres.

Heavy Water Training Reactor

Prototype of a proposed line of nuclear training and research reactors is a high-neutron-flux low-power reactor built by the Nuclear Development Corporation of America. Design of the 25 kW heterogeneous thermal reactor provides for small fuel load with a large experimental region remote from the active core. Fig. 2 shows the prototype under construction. A 5 ft diameter aluminum tank contains the heavy water moderator and reflector. Additional reflection is provided by a 1 ft thickness of high-purity graphite. In the center of the tank is an aluminium core assembly with three concentric rings with radial slots that can accommodate a maximum of 60 aluminum-clad enriched uranium-aluminum alloy fuel plates.

Zebra Camouflaged

The press office of the UKAEA has shown extreme reluctance to comment on a report in the *Financial Times* regarding a new fast breeder critical assembly. According to the report the experiment will be named ZEBRA (zero energy breeder assembly?) and the Authority appear to resort to the animal's natural defences for protection: undetectability. The authority have confirmed the name, but had no further statement to make on the nature of the experiment or on plans for construction.

Pump Cavitation by Bismuth

Studies incidate that cavitation by bismuth is a very real problem in the development of the liquid-metal fuelled reactor. Effects of cavitation were measured using several rotative speeds and stilling vanes upstream of the pump. Evidence was obtained for the validity of the mechanical theory of cavitation, and for concepts of the influence of gas and particle nuclei, and the interaction of corrosion with cavitation. (Cavitation by Bismith, H. L. Hovanec, 1959 ANS Winter Meeting, paper 6-7.)

Stainless Steel versus Zircaloy

Fuel cycles may be compared for optimised conditions using stainless steel and Zircaloy cladding. Not only burn-up, but the attainable specific power—that is the rate at which power is withdrawn from the fuel—must be considered. Increasing the specific power rating has two effects: fabrication costs increase because the maximum central temperature is increased; but the charges on the fuel inventory decrease owing to reduced requirements. At equal burn-up the optimum fuel cost using Zircaloy occurs at "a factor or two lower" than the specific power raging of optimised stainless-steel clad fuel. As a result an optimised core using Zircaloy cladding will be considerably larger. Cycle costs diminish with increasing burn-up at approximately the same rate for both materials. (Stainless Steel versus Zircaloy—The Effect of Fuel Cost Optimisation, R. J. Rickert, 1959 ANS Winter Meeting, paper 6-1.)

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AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—(*a*) Roads, pavements, earthworks and stormwater drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply and distribution. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially.

Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3746) giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 840

INDUSTRIAL GAS REPRESENTATIVES

With the increase in the development and utilisation of gas for Industrial purposes, further appointments are being made in the Midlands to meet the demand.

The work will involve investigation and submission of schemes for the use of gas for furnace heating and other industrial purposes.

Applications are invited from candidates with an appropriate university degree, or similar qualification. Experience of Industrial Gas is not essential as adequate training will be given.

The salary during the training period will be within the range of £733-£813 per annum, and subject to satisfactory completion of training, appointment to a permanent post on a higher grade will be made. The appointments are pensionable and subject to medical examination.

Applications, stating age, education, qualifications and experience, should be addressed to the INDUSTRIAL RELATIONS OFFICER, WEST MIDLANDS GAS BOARD, 6, AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15. B 281

MINISTRY OF TRANSPORT: CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1.1.60 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting 8/64/8. B 277

RESEARCH FELLOWSHIPS

RESEARCH FELLOWSHIP (3 years) in GOVERNMENT SCIENTIFIC ESTABLISHMENTS. Value £1150-£1400 (Senior) and £800-£1100 (Junior). Very wide range of topics, especially in the physical sciences. A few opportunities for biologists, e.g. in virology, taxonomy and physiology as applied to fisheries and veterinary research. Qualifications: normally first or second class honours degree; evidence of high standard of ability in research; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). No age limits. F.S.S.U.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting 8/5060/60. B 276

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED

Applications are invited for the following posts, in connection with work in Barrow-in-Furness or Dounreay, Scotland.

MECHANICAL ENGINEERS (*Barrow only*)

(*a*) An honours graduate to assist in running a department concerned with feasibility studies, the mathematical solution of design problems, together with the execution and analysis of basic experimental research in connection with marine propulsion.
(*b*) Several graduates possessing either ordinary or honours degrees to carry out work as outlined above.
(*c*) Men with good H.N.C.'s and exceptional experience in the theory and practice of some branch of heavy engineering, to assist in work as outlined above.

The work of the department is very interesting and covers an extremely wide field.

Previous training in Reactor Engineering will be an advantage, but is not essential, since arrangements will be made for training where necessary.

ELECTRICAL ENGINEER

(*Senior Appointment, Barrow only*)

to be responsible for the operation of all electrical machinery associated with a Prototype Naval Reactor and capable of advising on electrical matters.

Candidates should preferably have had Marine Experience and hold a University Degree, though exceptional men with H.N.C. would be considered. They should be members of the Institution of Electrical Engineers, or have the necessary theoretical and practical qualifications for membership.

Recent experience is desirable in the design and operation of heavy A.C. and D.C. rotating machinery, together with associated switchgear, control and distribution systems.

Arrangements will be made for the successful candidate to receive adequate specialised training.

SHIFT SUPERVISORS (*Senior Appointment*)

having Degrees in Mechanical Engineering and either land based or seagoing experience in operating steam machinery. Previous training in Reactor Engineering will be an advantage but is not essential, since arrangements for training will be made where necessary

ELECTRONIC ENGINEER

(*Senior Appointment*)

having a University Degree and industrial experience for work on Marine Installations associated with Naval Reactor Plant.

Previous Nuclear Experience is desirable.

OPERATING ENGINEER

preferably with a Degree in Mechanical Engineering and either land based or seagoing experience in operating steam machinery. Previous training in Reactor Engineering will be an advantage but is not essential, since arrangements will be made for training where necessary.

TEST ENGINEERS

are required having a good theoretical knowledge and a background of seagoing or other approved power plant experience. They should be capable of analysing test results arising from the operation of conventional steam machinery, and of writing coherent reports on their work.

H.N.C. is the minimum acceptable technical standard.

DESIGN ENGINEERS AND ENGINEERING DESIGNERS (*Barrow only*)

required with either a Degree or H.N.C. with distinction in Mechanical Engineering, for work on Nuclear Power Plants for Marine Propulsion.

Candidates, who should have had at least two years in a Drawing Office, must be capable of working on their own initiative.

Previous design experience in Marine Propulsion would be an advantage.

ELECTRONIC TECHNICIANS AND TROUBLE SHOOTERS

(*Staff Appointments*)

capable of diagnosing and rectifying faults in the instrumentation and electronic control gear associated with a Prototype Naval Reactor.

Candidates should have had previous industrial experience.

A knowledge of magnetic amplifiers will be an advantage.

Training Courses in Reactor Instrumentation will be arranged where necessary.

DRAUGHTSMEN (*Barrow only*)

possessing a minimum qualification of O.N.C., but preferably H.N.C. Men are wanted with experience in engine room layout, pipework, and in the production of detail designs and drawings.

There is a generous additional allowance for successful applicants who are required for duties at Dounreay.

Applications giving details of past experience, present work, responsibility and salary currently received should be addressed to:

The Manager, Marine Propulsion, Research & Development, VICKERS-ARMSTRONGS (ENGINEERS) LIMITED, Naval Construction Works, Barrow-in-Furness, Lancashire.

B 272

FEDERAL GOVERNMENT OF NIGERIA

ELECTRICAL INSPECTOR

Under the Chief Inspector to inspect electrical supply undertakings and large consumers installations including factories, mines and oilwells, and to investigate and conduct enquiries into electrical accidents.

Contract appointment for one or two tours. Salary range £1374-£1788. Gratuity of £37 10s. for each three months' satisfactory service. Quarters at moderate rent. Free passages. Allowance for children maintained in United Kingdom. Generous home leave.

Candidates must be A.M.I.E.E. or be exempt the Institutions examination and have been apprenticed to an electrical supply undertaking or large industrial undertaking with at least 7 years' experience of responsibility involving the planning, erection and maintenance of electrical transmission and distribution systems or works electrical plants. A thorough knowledge of electrical supply and wiring regulations as they apply in the United Kingdom is essential.

Write DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, stating full names, age, qualifications and experience, quoting BCD 99/14/014/D5. B 274

GOVERNMENT OF JAMAICA

EXECUTIVE ENGINEER (MECHANICAL)

PUBLIC WORKS DEPARTMENT

Under the Director of Electrical and Mechanical Services to control the maintenance and allocation of heavy earth-moving units, vehicles and general mechanical plants; to carry out a statistical analysis of the operating cost of all equipment; to co-ordinate with the Executive Engineer in charge of Workshops in the ordering of new equipment, etc.

Contract appointment for one tour of three years. Salary range £1400-£1600 a year. Gratuity 20 per cent. of salary. House provided at reasonable rent. Free passages.

Candidates up to 50 years must be A.M.I.Mech.E. with relevant knowledge and experience.

Write to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/32/021/D5. B 273

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

Applications are invited for a FULL-TIME SCIENCE TEACHING AND RESEARCH APPOINTMENT in the Department of Printing and Photographic Technology.

Candidates should have a degree in Physics or Chemistry or Mechanical and Electrical Engineering and be interested in the application of science to practical problems. A knowledge of the Printing, Photographic, Mechanical or Electrical Engineering Industries would be an advantage but is not essential. The duties include research which may provide opportunity of working for a higher degree.

Salary in the Scale £700 by £27 10s. to £1112 10s. by £37 10s. to £1150 per annum plus allowances for qualifications and training.

Application forms may be obtained from THE REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, MANCHESTER, 1, to whom completed form should be returned by Monday, 29th February, 1960. B 290

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

MECHANICAL RESEARCH ENGINEER

The College is engaged on a large scale research programme into the automatic control of machine tools with the support of D.S.I.R. A Senior Research Engineer is required to be responsible for the mechanical engineering aspects of the work, including the design, development and application of measuring and control devices. Special experience in the field of servomechanisms is essential.

Salary, according to qualifications, in the range of £1200 to £1500 per annum. Superannuation scheme.

Further particulars and form of application may be obtained from the REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, MANCHESTER, 1, to whom completed forms should be returned by Saturday, 27th February, 1960. B 289

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

Applications are invited for the post of SENIOR LECTURER IN THERMODYNAMICS, in the Department of Mechanical Engineering. Applicants should have had industrial or research experience and, preferably, possess a university degree. Encouragement will be given to undertake research and consulting work.

Salary scale £1550 by £50 to £1750 per annum, the commencing salary being determined by previous experience and qualifications. The post is pensionable.

Application forms and further information may be obtained from the REGISTRAR. (In reply please quote 4/D.) B 304

MANCHESTER REGIONAL HOSPITAL BOARD

ARCHITECTURAL, ENGINEERING AND SURVEYING STAFF

A substantial expansion of the hospital capital building programme offers valuable opportunities to ambitious Architects, Engineers, and Surveyors. Vacancies are available in the following grades. The salary scales quoted are at present under review.

(*a*) PRINCIPAL ASSISTANT GRADE SCALE II—£1195-£1420 a year;
Architects.
(*b*) SENIOR ASSISTANT GRADE—£1050-£1245 a year;
Architects
Quantity Surveyors
Engineers (Mechanical, Heating and Ventilating)
Engineers (Electrical).
(*c*) ASSISTANT GRADE—£730-£1055 a year;
Architects
Surveyors (Land and Quantity)
Engineers (Mechanical, Heating and Ventilating)
Engineers (Electrical).
(*d*) SUB-PROFESSIONAL GRADE—£545-£765 a year;
Architects
Surveyors (Land and Quantity)
(*e*) DRAUGHTSMEN—£445-£660 a year.

Candidates for posts listed under (*a*), (*b*) and (*c*) must possess full professional qualifications and for posts under (*d*), intermediate qualifications. Draughtsmen must have had at least 3 years' previous experience. All posts are subject to National Health Service conditions and are superannuable.—Application forms, to be returned by 29th February, 1960, are obtainable from the SECRETARY OF THE BOARD, CHEETWOOD ROAD, MANCHESTER, 8. B 225

AIR MINISTRY

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and M.T.C.A. Stations. The work of Station Engineer (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineer (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Commencing salary according to age, qualifications and experience. Salary ranges £680 to £850. Candidates must hold O.N.C. Electrical or Mechanical/City and Guilds Electrical Technicians Certificate/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience. Opportunities for promotion up to Technical Grade A, maximum salary £1565 (National Rate) and pension prospects. Five-day week, three weeks three days leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applications normally from natural born British subjects only, up to age 55 years. —Write, stating age, qualifications and experience, to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 845

HUDDERSFIELD COLLEGE OF TECHNOLOGY

Principal: Dr. W. E. SCOTT, M.B.E.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Required as soon as possible:—

(1) GRADE "B" ASSISTANT to teach Production Engineering subjects mainly in courses up to Higher National Diploma (Production), including Principles of Engineering Production, and to carry out research relating to Production Engineering.
(2) TWO GRADE "B" ASSISTANTS to teach Mechanical Engineering subjects mainly in courses up to Higher National Certificate, including Workshop Technology for Ordinary National Certificate.

Salary (Burnham Scale):—£700 p.a. by £27 10s. p.a. to £1150 p.a.

There are additions for approved qualifications and training and the commencing salary may include increments for approved industrial experience.

Forms of application and further particulars obtainable from the PRINCIPAL, to whom applications should be returned without delay.

H. GRAY,
CLERK TO THE GOVERNORS.

B 299

UNIVERSITY OF LONDON

Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology or Physics. The Fellowships will be within the range of £800-£1000 per annum and will normally be tenable from 1 October, 1960, for three years. Family allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON SENATE HOUSE, W.C.1. Applications must be received not later than 30th April, 1960.

UNIVERSITY OF LONDON: Applications are invited for a TURNER & NEWALL RESEARCH FELLOWSHIP in Engineering, Inorganic Chemistry or Physics. The Fellowship will be within the range of £800-£1000 per annum and will normally be tenable from 1st October, 1960, for three years. Family Allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1. Applications must be received not later than 30th April, 1960.

G 843

CITY OF BIRMINGHAM
EDUCATION COMMITTEE
VACANCIES FOR TEACHING STAFF
IN TECHNICAL COLLEGES

Applications are invited for the following posts to commence duty on 1st September, 1960. Separate application forms for each post and further particulars may be obtained from the Principal of the College concerned (stamped addressed envelope) and should be returned to him as early as possible. Burnham (Further Education) Salary Scales as follows:—

Lecturer: Men: £1370 by £35 to £1550.
Women: £1100 by £28 to £1240.
+ equal pay increments.

Assistant Grade "B":
Men: £700 by £27 10s. to £1150.
Women: £630 by £22 to £920.
+ equal pay increments.

Assistant Grade "A":
Men: £520 by £27 10s. to £1000.
Women: £468 by £22 to £800.
+ equal pay increments.

Additional increments above the minimum of the above scales may be granted for time spent in teaching, industry, commerce, professional work or research. There are also additions to the scales for Grade "B" and Grade "A" Assistants for a degree or for equivalent professional qualifications.

ASTON TECHNICAL COLLEGE,
Whitehead Road, Aston, Birmingham, 6.
Principal: D. D. STOCKLEY, B.Sc., M.I.Mech.E.
LECTURER in Mechanical Engineering subjects up to Higher National Certificate standard. Degree or equivalent desirable; previous teaching and industrial experience essential.

HANDSWORTH TECHNICAL COLLEGE,
Golds Hill Road, Birmingham, 21.
Principal: H. MARSHALL, B.Sc.Tech., A.M.I.Mech.E., A.M.I.Prod.E.
ASSISTANT GRADE "A" to teach elementary classes in C.G.L.I. Machine Shop Engineering Courses and particularly Workshop Practice and Processes.

MATTHEW BOULTON TECHNICAL COLLEGE,
Suffolk Street, Birmingham, 1.
Principal: J. C. MARTIN, M.A., A.M.I.E.E., A.M.Brit.I.R.E.
ASSISTANT GRADE "B" for City and Guilds Fabrication of Steel Courses.

E. L. RUSSELL,
CHIEF EDUCATION OFFICER. B 322

EAST AFRICAN RAILWAYS
AND HARBOURS ADMINISTRATION
ASSISTANT ENGINEER (MECHANICAL)

To undertake supervision of Plant Repair Workshops and inspection of Civil Engineering machinery and plant.

Pensionable appointment. Salary range £1170-£1755. Free passages. Free accommodation, rented furniture.

Candidates 28-40 years, must be A.M.I.Mech.E. with thorough knowledge of the operation and maintenance, including major overhaul, of all mechanical plant used for civil engineering works and have experience of routine workshops accounting, storekeeping and general staff administration.

Write DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD 173/031/D5. B 315

PRINCIPAL SCIENTIFIC OFFICER

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Pensionable post at National Engineering Laboratory, East Kilbride, Glasgow, for engineer for research on the application of servo control to machine tools. Qualifications: normally first or second class honours degree in engineering or high professional attainment. Experience of electrical servo design and development and a good knowledge of servo-theory is essential. Knowledge of hydraulic servo techniques or machine tool design an advantage. Salary scale (men) £1420-£2020. Starting pay may be above minimum. Good housing prospects. Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/5099/60/12. Closing date 10th March, 1960. B 313

RUSTON & HORNSBY, LIMITED
LINCOLN

require

SENIOR MECHANICAL ENGINEERS

for design and development work in the Turbomachinery Group. Qualified engineers who have a thorough knowledge of thermodynamics, aerodynamics and strength of materials, and who have applied their knowledge for several years to steam turbines, gas turbines, compressors or related fields, are invited to apply.

Applicants should be capable of carrying out design studies and taking complete charge of new projects.

Engineers with some of the above qualifications are also required to assist in this work.

All posts are pensionable.

APPLY STAFF MANAGER.

B 296

AIR PRODUCTS (G.B.) LTD.,

CHIEF MECHANICAL ENGINEER

This leading Company serving the Government, Chemical, Steel and Gas industries requires a fully Qualified Engineer to manage its machinery activity.

Requirements

- Understanding of the fundamentals of applied mechanics and thermodynamics.
- Thorough grounding in commercial practice related to the application of centrifugal and reciprocating machinery.
- Ability to negotiate at Management level with Machinery Suppliers in Great Britain and on the Continent.

The successful candidate will spend a period of time with our Parent Company in the United States, in order to gain an appreciation of the technical and commercial aspects of our business.

Write to:—

Personnel Manager
AIR PRODUCTS (G.B.) LIMITED
49/50, Poland Street, London, W.1. B 293

Electronic Laboratory Assistants

required

for design and development of equipment for structural and flight test programmes, also for servicing of existing servo-equipment, computers, power amplifiers, etc.

Technical education to O.N.C. or H.N.C. level desirable but experienced candidates without these qualifications will also be considered.

Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary required, and quoting ref. H.A.L./104/ENG, should be addressed to:

THE PERSONNEL MANAGER,
HUNTING AIRCRAFT LTD.,
LUTON AIRPORT,
BEDS.

B 311

T. I. (GROUP SERVICES) LIMITED

(THE SERVICE COMPANY OF THE TUBE INVESTMENTS GROUP)

A number of vacancies are available in the Plant Development Department of the above company for experienced

DESIGN ENGINEERS.

The work of the department includes a wide range of plant design, development of prototype machines, factory planning, progressing installation programmes, etc.

Excellent opportunities exist for promotion

Applications are invited from men of 28-35 years of age with experience in the design of special-purpose machines and having as a minimum qualification Higher National Certificate or the equivalent. They should be sent, giving full details of qualifications, experience, present salary, etc., to the **PERSONNEL MANAGER, T.I. (GROUP SERVICES) LTD., ROCKY LANE, ASTON, BIRMINGHAM 6.** B 206

CHIEF DRAUGHTSMAN

Must be time-served engineer and capable of leading a medium-size drawing office engaged upon the design of medium to light high grade machines of mechanical, hydraulic and partly electrical types.

Important qualifications are enthusiasm, an inventive mind, a modern approach, a willingness to co-operate, and the previous holding of a similar post.

There are excellent prospects for the right type of man.

Write, giving age, present earnings, and fullest particulars of experience and posts held to:

MR. H. M. DENISON,
SAML. DENISON & SON, LTD.,
HUNSLET FOUNDRY,
LEEDS, 10.

B 317

LEEDS COLLEGE OF TECHNOLOGY

CALVERLEY STREET, LEEDS, 1
Principal: C. CHEW, M.Sc.Tech., F.R.I.C.

Applications are invited for the post of:

ASSISTANT LECTURER (Grade "B")

IN MECHANICAL ENGINEERING

duties to commence as soon as possible.

Applicants should have had good industrial experience and possess recognised technical qualifications.

Burnham salary scale: £700 by £27 10s. 0d. to £1150.

In fixing the initial salary, full allowances will be made for training, industrial and teaching experience.

Further particulars and form of application to be returned by the 26th February next, may be obtained by sending a stamped addressed foolscap envelope to the Principal of the College.

GEORGE TAYLOR,
CHIEF EDUCATION OFFICER.
EDUCATION DEPARTMENT,
Leeds, 1. B 266

UNIVERSITY OF LONDON
KING'S COLLEGE

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for this post. Candidates should have a good Honours degree and some experience of teaching and/or research in Engineering Science. Industrial or other professional experience is also desirable.

The salary will be on the scale £900 by £50 p.a. to £1350 by £75 p.a. to £1650, with starting point according to qualifications and experience. A London allowance of £60, family allowances, and F.S.S.U. benefits will also be payable.

The formal conditions of appointment and application forms may be obtained from the **REGISTRAR, KING'S COLLEGE LONDON, STRAND, W.C.2.** Completed forms must reach him by February 29th. B 211

ENGLISH ELECTRIC RUGBY

DRAUGHTSMEN

with experience of detail design or plant layout are required for the Steam Turbine Division of English Electric.

Applicants should preferably be of H.N.C. standard and have a minimum of three years D.O. experience. This can be of a general mechanical design nature, or alternatively for layout work, should include extensive experience of piping work associated with chemical, oil or steam plants. Write giving full details to DEPT. C.P.S., MARCONI HOUSE, 336/7, STRAND, LONDON, W.C.2, quoting reference E 1199Y. B 291

A SENIOR PRODUCTION ENGINEER

is required by a progressive Company engaged in the Mass Production of

LIGHT ENGINEERING COMPONENTS

in the South Midlands.

The business is highly competitive and the essential features of our forward programme are increasing productivity coupled with the highest standards of precision; it is towards achieving and maintaining these ends that the person appointed will be required to work, through the study of individual technical and practical production problems.

The salary, conditions and prospects offered will be in keeping with the high degree of importance attached to this new appointment.

Applications are invited from qualified Mechanical Engineers who have had a minimum of 10 years' experience in responsible technical positions of a similar nature. They should give full details of background, experience and present position, in the fullest confidence, to BOX B 295, Offices of ENGINEERING.

THE ASSOCIATED PORTLAND CEMENT MANUFACTURERS LIMITED

require several

SENIOR AND JUNIOR MECHANICAL ENGINEERING DRAUGHTSMEN

for work on plant layout schemes and details at Head Office, Westminster.

Experience in heavy machinery, plant layout and mechanical handling an advantage. Applicants with H.N.C. in Mechanical Engineering preferred for Senior Posts.

The Company offers good salaries and working conditions, pension fund and profit sharing bonus.

Replies giving particulars of training and experience will be treated in full confidence and should be sent to the following, marked "Personal":—

THE MANAGER,
CENTRAL ENGINEERING DEPARTMENT,
ASSOCIATED PORTLAND CEMENT MANUFACTURERS, LTD.,
PORTLAND HOUSE, TOTHILL STREET,
LONDON, S.W.1. B 159

TECHNICAL READER OR ENQUIRY ENGINEER

TECHNICAL READER OR ENQUIRY ENGINEER required in the Library and Information Department of a large Midland Group of Industrial Companies, to study technical literature in the production engineering field, to advise executives and to handle investigations on particular enquiries. Emphasis is placed on knowledge of production engineering, machine and press tools and welding techniques. Some working knowledge of foreign languages is desirable. Good opportunities for future advancement depending largely on initiative and ability of person selected. Salary according to qualifications, experience and potentiality. Minimum £900 to £1000 per annum. Superannuation scheme, canteen and social amenities. Write giving details of qualifications and experience and personal details to—

PERSONNEL MANAGER,
RUBERY OWEN & CO., LTD.,
P.O. BOX 10,
DARLASTON, WEDNESBURY, STAFFS. B 282

DRAUGHTSMEN

are required by

SAUNDERS VALVE COMPANY LTD.,
Blackfriars Street, Hereford.

The vacancies are for qualified draughtsmen with experience in Tool Design, Planning Layouts and Die and Shell Mould design for aluminium castings.

Salary will be commensurate with ability and experience. Age 25 upward.

Contributory pension scheme, 5 day week.

Apply in writing giving full particulars of age, education and experience in confidence to

Chief Engineer
at the above address
B 303

W. H. ALLEN SONS & CO. LTD.

invite applications for the following vacancies at their Atlas Works, Pershore, Worcestershire.

SENIOR AND JUNIOR DRAUGHTSMEN for expanding Gear Drawing Office. Candidates with general mechanical engineering experience, not necessarily connected with gearing would be considered.

CONTRACTS ENGINEERS for expanding Gear Sales and Service Section. The work involves estimating and the preparation of tenders, including after-sales service. Candidates should be at least 24 years of age and have received a recognised engineering training, with subsequent experience in drawing or estimating office.

The above appointments cover interesting work on high-power gearing, individually designed for special industrial and marine applications. Permanent pensionable positions. Canteen facilities. Travelling allowance according to distance from Pershore. Apply, in confidence, to PERSONNEL MANAGER (REF. 829/275), ATLAS WORKS, PERSHORE, WORCESTERSHIRE. B 301

ROYAL NAVAL COLLEGE · GREENWICH

Assistant Professor of Nuclear Science and Technology

Applications are invited from men with high academic qualifications in physics or mathematics and with experience in (i) experimental reactor physics, (ii) design of critical and sub-critical experiments, and (iii) safety precautions associated with (i) and (ii), and with use of highly radio-active sources. The duties will include lecturing on reactor physics and kinetics; design and supervision of experiments; supervision of safety aspects. Secondment from Scientific Civil Service considered. London salary scale £2400-£2700. Starting salary may be above minimum. F.S.S.U. Single accommodation available. Application forms may be obtained from CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1. Please quote S/5101/60. Closing date 10th March, 1960.
B 312

THE BURMAH OIL COMPANY (PIPE LINES) LTD.

invites applications for the following appointments in connection with the construction of a major crude oil pipeline in India:

QUALIFIED CIVIL ENGINEER
with previous experience of deep excavation in waterlogged ground and with knowledge of draglines, dredging and dewatering equipment.

QUALIFIED STRUCTURAL ENGINEER
with experience of field erection of steel structures.

Salaries, paid in Rupees and free of Indian Taxation, will be related to qualifications and experience, and free single accommodation and messing will be provided.

Replies giving full details of experience and personal particulars to: The Burmah Oil Co. (PIPE LINES), Ltd., Britannic House, Finsbury Circus, London, E.C.2.
B 320

DRAUGHTSMEN

The central research organisation of the **VICKERS GROUP AT SUNNINGHILL, BERKS,** has vacancies for work in close association with Design Engineers and Research Scientists in Electrical, Mechanical, Hydraulic, and Nuclear Engineering. Salaries are commensurate with ability, experience and qualifications. Applications to:

VICKERS RESEARCH LIMITED,
CHARTERS,
KING'S ROAD,
SUNNINGHILL,
BERKS.
B 326

LLOYD'S REGISTER OF SHIPPING

require a

MECHANICAL ENGINEER

for their testing and experimental laboratory at Crawley, Sussex. Applicants should possess a University Degree in Mechanical Engineering, have at least two years' experience of general mechanical engineering and at least two years' industrial research experience relating to fatigue of machinery components. A knowledge of metallurgy would be an advantage. The post offers good prospects in the Society's service. Age limits 28/40 years. Commencing salary £1100/£1500 p.a. Apply to—THE SECRETARY, LLOYD'S REGISTER OF SHIPPING, 71, FENCHURCH STREET, LONDON, E.C.3. B 328

THE DISTILLERS COMPANY LIMITED

SENIOR ESTIMATOR (MALE)

The Distillers Company Limited has a vacancy in its Engineering Division in the West End of London for a Senior Estimator. The post calls for considerable and varied experience in estimating construction costs of chemical plant projects including buildings, steelwork, off-site services and associated equipment, and will carry a four-figure salary. Candidates should be over 35 years of age, with adequate engineering training, and a recognised qualification in engineering is desirable.

Write:
STAFF MANAGER,
THE DISTILLERS COMPANY LIMITED,
21-22, BOLTON STREET,
LONDON, W.1.

Quote Ref. 12/60E. B 285

APPOINTMENTS OPEN

MECHANICAL ENGINEER

A MECHANICAL ENGINEER is required to design and build experimental test rigs mainly for use at low temperatures. The work involves very close collaboration with Chemists, Chemical Engineers and Physicists who will be using the rigs.

Applications are invited from graduates or candidates with equivalent qualifications who should write to THE SECRETARY, BRITISH OXYGEN RESEARCH & DEVELOPMENT, LTD., DEER PARK ROAD, LONDON, S.W.19. B 280

AERONAUTICAL ENGINEER

THE AIR REGISTRATION BOARD has a vacancy for an AERONAUTICAL ENGINEER, not exceeding 30 years of age on 1st January, 1960, for employment in North Midland Area. Applicant should have had full apprenticeship, an engineering degree or H.N.C., and not less than five years' experience in the manufacture, inspection or design of gas turbine engines.

The post is permanent and the successful applicant will be required to join the Superannuation Fund. Salary according to age, qualifications and experience.

Applications with full personal and technical details should be sent to THE SECRETARY, AIR REGISTRATION BOARD, CHANCERY HOUSE, CHANCERY LANE, LONDON, W.C.2. B 275

STRUCTURAL ENGINEER

B.B.C. requires STRUCTURAL ENGINEER in London for work in connection with high masts and similar structures. Candidates must be under 40, physically fit, and able to undertake inspection work at height. They must have drawing office experience with structural design background. Successful candidate expected to travel anywhere within United Kingdom. Salary in scale £935 with annual increments to maximum of £1185 p.a.—Requests for application forms to ENGINEERING RECRUITMENT OFFICER, BROADCASTING HOUSE, LONDON, W.1, quoting ref. 60.E.13.Engg.
B 287

ENGINEERS

ENGINEERS, CIVIL AND MECHANICAL—temporary—required by Iron Ore Mining Company for one tour of approximately 18 months duty in BRITISH WEST AFRICA. Civil Engineer to supervise foundation and steelwork contracts, and Mechanical Engineer to supervise installation of plant and machinery including electrics in an ore concentrating plant. Engineers with previous experience contract supervision essential. Salary £1900 per annum plus bonus plus for married man marriage allowance at the rate of £10 per month and children's allowance at the rate of £5 per month for each child under 18. Dependants Income Scheme and free Life Assurance. Return passage paid. Initial kit allowance. Free furnished accommodation and medical attention.—Write giving full details of experience stating age, married or single to SIERRA LEONE DEVELOPMENT CO., LTD., DEPT. M.P.5, CITY GATE HOUSE, FINSBURY SQUARE, LONDON, E.C.2. B 288

SERVICES ENGINEER

SERVICES ENGINEER required for a chemical factory preferably with experience of Water Tube and Lancashire Boilers, Refrigeration, Compressed Air, Water Filtration and distribution. Must have enthusiasm and initiative for planning a services development scheme. The post is permanent and offers opportunity for the right man.—Apply to CHIEF ENGINEER, MESSRS. HICKSON & WELCH LIMITED, INGS LANE, CASTLEFORD, YORKSHIRE. B 300

MECHANICAL DRAUGHTSMAN

PILKINGTON BROTHERS LIMITED, Sheet Works, have vacancies in their Drawing Offices for MECHANICAL DRAUGHTSMAN. Applicants should have had experience in plant layout and machine design and should have a Higher National Certificate in Mechanical Engineering or be working for it.

Assistance with house purchase, recreational and canteen facilities, five-day week, superannuation scheme.

Applications should be addressed to the PERSONNEL OFFICER, PILKINGTON BROTHERS LIMITED, SHEET WORKS, ST. HELENS, LANCASHIRE. B 294

REPRESENTATIVES

REPRESENTATIVES wanted for correspondence abroad, high earnings, written instructions.
Write: FORTUNA PUBLISHING CO., VIENNA 1/8, POSTFACH 40, AUSTRIA. G 824

ASSISTANT RESIDENT ENGINEERS

Water Tube Boiler Contractor requires ASSISTANT RESIDENT ENGINEERS for site construction. Previous shop and site experience is essential and technical qualifications to H.N.C. would be an advantage. Preferably age group 28-40. Salary would depend on experience and qualifications but would not be less than £800 p.a. plus subsistence allowance when working on site. Pension Scheme.—Full particulars of age, qualifications and career, quoting reference WT7, should be sent to BOX B176, Offices of ENGINEERING.

SENIOR DRAUGHTSMAN

MAY & BAKER LTD., DAGENHAM, ESSEX, require a SENIOR DRAUGHTSMAN with experience in the design and layout of chemical or similar plant installations. Applicants should have technical qualifications to Ordinary National Certificate level or higher. Salaries are reviewed annually. There is a Pension Fund and Life Assurance Scheme in operation. Excellent canteen and sports facilities. —Apply initially in writing to the PERSONNEL OFFICER, quoting Reference No. 19/60. B 217

DRAUGHTSMAN, MECHANICAL (SENIOR)

DRAUGHTSMAN, MECHANICAL (SENIOR) required by the British Drug Houses Ltd. for layout and special machine development in their chemical laboratories. H.N.C. or equivalent preferred. Five-day week, Canteen, Sports Club, Pension and Profit Sharing Schemes—Apply in writing, stating age and educational attainments, to the STAFF MANAGER, GRAHAM STREET, CITY ROAD, N.1. B 241

LUBRICATION ENGINEERS

CENTRALUBE LTD., Lubrication Engineers, require the following Mechanical Engineers, preferably qualified, with heavy engineering and/or sales experience.

Personal Assistant to Chief Engineer, based at Head Office, London.

Area Engineers for Scottish and Yorkshire Areas. Engineers for London Office, N.18.

Full details of age, experience and salary required, in confidence, to MANAGING DIRECTOR, CENTRALUBE LTD., PARK ROYAL ROAD, LONDON, N.W.10. B 253

MECHANICAL ENGINEER

MECHANICAL ENGINEER required for the design of new projects. Age not less than 30. Preferably A.M.I.Mech.E., with some year's experience in the chemical (or allied) industry. Salary range about £1200-£1500 p.a., according to age and qualifications. The appointment is permanent and pensionable.—Applications should be addressed to the PERSONNEL MANAGER, A. BOAKE, ROBERTS & CO., LTD., CARPENTERS ROAD, LONDON, E.15. B 331

CIVIL ENGINEER

CIVIL ENGINEER required for the design of new projects. Preferably A.M.I.C.E. with experience in industrial building design. Salary range about £1200-£1500 p.a., according to age and qualifications. The appointment is permanent and pensionable.—Applications should be addressed to the PERSONNEL MANAGER, A. BOAKE, ROBERTS & CO., LTD., CARPENTERS ROAD, LONDON, E.15. B 333

WEST AFRICA

CHIEF ENGINEER required for expanding structural and general engineering company in Lagos, Nigeria. Age 30/40. University Engineering degree, or equivalent. Works and administrative experience. Free first class passages, free fully furnished accommodation and free medical attention. 15/18 months tours followed by three months fully paid leave. A good salary for this important post will be paid to the applicant with the right qualifications.—Apply in writing with full details of career to DORMAN LONG & CO., LTD. (REF. W/A), TERMINAL HOUSE, 52, GROSVENOR GARDENS, LONDON, S.W.1. B 323

MECHANICAL ENGINEER

MECHANICAL ENGINEER required by leading British merchant company with Head Office in London, for its Branch in South India where it owns a large engineering works. The duties are concerned with sales and engineering aspects of a wide range of plantation equipment. Applicants should be single under 30 and Graduate or Associate Members of the Institution of Mechanical Engineers. Full details of remuneration, housing, leave, medical scheme, retirement and other benefits will be supplied at interview.—BOX B 319, Offices of ENGINEERING.

LAING

MECHANICAL DESIGN ENGINEERS

The following vacancies exist in the Laing Group of Companies. The work is of an interesting nature and concerned with the development of new machines and processes connected with the Building and Civil Engineering Industries.

SENIOR DESIGNER

required with experience in factory layout and factory machinery, for THERMALITE YTONG LIMITED. The work will involve the development of equipment for the production of high class building components. A.M.I.Mech.E. qualifications with experience in Mechanical Handling required.

SENIOR DESIGNERS

for the Research and Development Centre of John Laing and Son Limited at Boreham Wood. Applicants should be of A.M.I. Mech.E. standard and have experience in the development of new and improved types of CONTRACTORS' PLANT.

ASSISTANTS

to the above are required of H.N.C. or graduate level, some experience required.

GRADUATE MECHANICAL & CIVIL ENGINEERS

with Site experience in the operation of contractors Plant, for work involving the study, performance and development of the mechanisation techniques applied within the Contracting Industries.

All these posts are permanent and progressive. Pension Scheme.

Applicants should write in the first instance to:

Personnel Manager (Ref. M.D.E.3)
John Laing and Son (Holdings) Limited,
Page Street, N.W.7.

B 234

MAVOR & COULSON LIMITED

invite applications for appointment of Manager and Technical Salesman, London and Southern England. Experience of Surface Mechanical Handling and Conveying. Remuneration by salary and commission related to experience and ability. Apply in writing initially to MANAGING DIRECTOR, BRIDGETON, GLASGOW.

B 268

QUALIFIED CIVIL ENGINEER

QUALIFIED CIVIL ENGINEER required for position of Resident Engineer in charge of Airport buildings and constructional works in West Africa. The appointment will be for three years subject to home leave. Applicants to forward particulars of training and experience by 7th March, 1960, to: NORMAN & DAWBARN, 7, PORTLAND PLACE, W.1. B 284

APPOINTMENTS WANTED

WANTED—ROOM AT THE TOP

BRITISH MECHANICAL ENGINEER, 35, married, interested in vacancy in design/development team. Heavy engineering apprenticeship 2½ years, B.Sc., A.M.I.Mech.E., D.O. and test rigs with hydro-dynamic bearing company 1¼ years, aero-engine repair supervision in R.N. 2¼ years, jet engine and piston engine development with leading company 4 years. Lieutenant (E) Canadian Navy 3 years (sea going engineer 2 years), performance work destroyer machinery 1 year, marine machinery design investigation, steam heat balances, rig testing, gas turbine projects 3 years. Currently resident Eastern Canada.—BOX B 271, Offices of ENGINEERING.

TECHNICAL MANAGER

Required for old-established and progressive engineering firm of medium size known the world over.

Products cover high-quality medium-heavy to light mechanical and hydraulic machinery in small batches for a great variety of industrial applications both in production and research.

An intensive development programme is followed which must be maintained and augmented with suitable instrumentation of mechanical, electrical and electronic kinds.

Qualifications include thorough technical knowledge and practical experience of engineering, and ability both to control design staff and to foster the whole of the Firm's technical activities from a broad and progressive angle.

Fullest particulars should be given of academic qualifications, practical experience, posts held, type of work handled, and of contacts with industry and research establishments.

Write, stating age, present earnings and when available, to:—

The Managing Director,
SAML. DENISON & SON LIMITED,
HUNSLET FOUNDRY,
LEEDS, 10.

B 133

LEADING MIDLAND MACHINE TOOL COMPANY

have a vacancy for a

SALESMAN

to specialise in the sale of high grade Heavy Machine Tools. Good engineering training essential. Knowledge of steel industry an asset. Responsibilities include travelling the whole of the country and occasionally abroad. A car will be provided and there is an attractive pension scheme. Good basic salary and commission.—Applications giving full details of past experience together with age and salary expected, to BOX B 232, Offices of ENGINEERING.

CHIEF DESIGNER

Applications are invited for the post of Chief Designer in a Structural Engineering Company in the Lanarkshire area. The post is a senior one and candidates should be between 35 and 45 years of age and should have a University degree or M.I.Struct.E. The Company is engaged in the fabrication of medium type buildings and a wide range of experience in the design of conventional truss and portal frame structures is necessary. The successful candidate will be required to control a small team of Designers and be able to take decisions on his own initiative. The post is a permanent one and carries with it the benefits of contributory pension scheme and five-day week. A salary in the region of £1200 per annum would be considered for a suitable candidate. Please reply giving complete details of education, qualifications, training and experience to BOX B 329, Offices of ENGINEERING.

INSTRUMENT ENGINEERS

Candidates must have some experience in Instrument Engineering, and either University Degree or H.N.C. Experience should preferably be in refinery process instrumentations. Operating experience would be an advantage. Duties of the successful applicants will cover the selection of instruments, the determination of their location, and applications in the process; preparation of process control diagrams, instrument specifications and data sheets; writing of requisitions and review of vendors' quotations; instrument calculations, locating the physical position of instruments and the preparation of instrument board layouts.

Above average salaries, comprehensive personnel benefits include contributory pension scheme, excellent working conditions, luncheon vouchers, Social Club, etc.

Please write to the Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION

7-10. CHANDOS STREET, CAVENDISH SQUARE LONDON, W.1. *TEL: MUSEUM 4010*

quoting reference 155/H

B 316

TRAIN FOR A CAREER IN TEACHING

ENGINEERING SUBJECTS

Persons aged between about 25 and about 45, with good industrial experience, are invited to apply for training as FULL-TIME TEACHERS OF ENGINEERING SUBJECTS IN TECHNICAL COLLEGES AND SCHOOLS.

EXCELLENT CAREER PROSPECTS

NEXT COURSE: SEPTEMBER, 1960, TO JUNE, 1961.

Applicants should hold suitable qualifications, *e.g.*, a university degree, associate or graduate membership of a professional institution, Higher National Certificate, Final or Full Technological Certificate of the City and Guilds of London Institute.

NO TUITION FEES:
PERSONAL, MAINTENANCE, DEPENDANTS' AND TRAVELLING GRANTS PAYABLE

For details write immediately, quoting 8/21, to either

THE DIRECTOR, BOLTON TRAINING COLLEGE, MANCHESTER ROAD, BOLTON.
THE DIRECTOR, HUDDERSFIELD TRAINING COLLEGE, HOLLY BANK ROAD, HUDDERSFIELD.
THE PRINCIPAL, GARNETT COLLEGE, 83 NEW KENT ROAD, LONDON, S.E.1.

B 204

RICHARD SUTCLIFEE LIMITED

Owing to expansion in our Development Department we require:—

TWO GRADUATE DEVELOPMENT ENGINEERS

and

TWO DEVELOPMENT DESIGN ENGINEERS

GRADUATE DEVELOPMENT ENGINEER (INDUSTRIAL)

Applicants should preferably be between 30 and 35 years of age, have graduated in Mechanical Engineering, have experience of high speed rotating machinery and mechanical handling equipment for bulk materials.

GRADUATE DEVELOPMENT ENGINEER (MINING)

Applicants should preferably be between 25 and 30 years of age, have graduated in Mining Engineering and have completed a further year's study in Mechanical Engineering. Experience in the development of mining machinery, especially of rock drilling and allied equipment would be an advantage.

DEVELOPMENT DESIGN ENGINEERS

Applicants should preferably be between 28 and 35 years of age, must have passed Higher National Certificate in Mechanical Engineering or its equivalent and have experience of at least one of the following:—Drilling machinery, high speed rotating machinery, gear boxes, presses or hydraulic equipment.

These are interesting and progressive appointments involving the improvement of existing products and the development of new.

Salaries will be on a generous scale commensurate with qualifications and experience, and will be supplemented by a contributory pension scheme.

Applications, which will be treated in confidence, should set out chronologically full details of education, technical training, experience and the usual personal information, and should be addressed to the **PERSONNEL MANAGER, UNIVERSAL WORKS, HORBURY, NEAR WAKEFIELD.** B 283

SALES MANAGER

A well-established company in the Midlands acting as the U.K. Marketing Organization for a world-famous manufacturer of an engineering component of the widest application requires an experienced Manager to direct a Sales Organization including market research throughout the country. There are ten Branches in the principal centres of industry with an external sales force of 60. Candidates must have a sound record of selling and good connections in the engineering and allied industries. A knowledge of German would be an advantage. Preferred age 35 to 45. Starting salary up to £2,000 with bonus and non-contributory pension fund. Car provided. This is not a desk job but one for an active and intelligent man who knows how to attract customers and give them good service.

Please reply in confidence to:

Robert Clive (Consultants) Limited

Appointments Consultants

27, ALBEMARLE STREET, LONDON, W.1 B 302

BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION

Applications are invited for appointments to the

DEVELOPMENT STAFF

and to the

BRIDGE DEPARTMENT

Candidates should be young men with some experience in the design and detailing of steel frame buildings with knowledge of B.S.449 or with experience in the design of steel bridges with knowledge of B.S.153. Five-day week and luncheon vouchers. Admission to non-contributory pension scheme after qualifying period.

Apply in confidence to the TECHNICAL ADVISER, BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION, ARTILLERY HOUSE, ARTILLERY ROW, LONDON, S.W.1, giving fullest details with salary required. B 174

STRUCTURAL DRAUGHTSMAN

Applications are invited for the post of Squad Leader in the Drawing Office of a Structural Engineering Company in the Lanarkshire area. Candidates should be between 35 and 45 years of age and should have served an apprenticeship in an Engineering Workshop and had about 15 years' experience. Experience of detailing heavy Structural Steelwork is essential. The successful candidate will control a team of Draughtsmen. This is a senior post and a salary of £900 per annum will be paid to the successful applicant. The post is a permanent one and carries with it the benefits of contributory pension scheme and five-day week. Please reply giving complete details of education, training and experience to BOX B 330, Offices ENGINEERING.

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
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SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Divided Steel Prospects

That some orders for forgings for United Kingdom electrical generating plant are being lost to continental firms for reasons of price is perhaps the most serious part of the annual statement by Sir John Green, chairman of THOS. FIRTH AND JOHN BROWN.

His detailed survey of the group's year, in which the gross surplus fell by £798,336 from the 1958 level to £5,067,543, shows how its fortunes are divided into two quite distinct categories.

The demand for special steels is rising to high levels and orders placed are even higher. It cannot yet be assessed how much of the demand is due to the anxiety of users to build up stocks. Bearing this qualification in mind, the long term outlook in this section is felt to be promising and proposals for expansion of capacity at the Beardmore plant and in Sheffield are being examined.

The FIRTH-DERIHON company had a good year, partly from larger turnover, partly from bringing into use new equipment for stampings for the car industry. It has in hand developments at its Darley Dale works to meet changed requirements from drop stamping.

The Iron and Steel Board have given permission for a new scheme at the works of the SHEPCOTE LANE ROLLING MILLS which will give a 40 per cent increase in output of sheet and strip steel.

The chairman's review takes on a gloomier note when he reports that not only has the demand for heavy forgings and castings for the shipbuilders fallen still further but at the end of the year orders still to be carried out were much smaller than twelve months before.

There appears no prospect of an early improvement in this situation. What orders there are available are fought for both at home and abroad.

Despite the greater amount of generating capacity being installed the larger units being used reduce the total amount of forgings and castings. This not only cuts down the tonnage wanted but steps up the metallurgical and technical problems. Larger capacity, and therefor more costly, plant is needed.

It follows from this that the risks involved in carrying such costly capital equipment against the possibility of winning contracts that are fewer and where competition is more fierce become very much greater.

Where the Money Comes From

Some of the financial facts underpinning the great increase in consumer demand that followed the removal of the credit restrictions are being given in detail as the annual reports of the banks appear.

The BOWMAKER finance house reveals that at the end of its financial year, 31 October, 1959, the hire purchase debt owed to the group was £51,100,891. A year before it had been £22,394,197. With the greater competition to do business on credit terms the profit margins have toppled but the chairman, Sir Arthur Morse, explains that there is "ample compensation" for this in the larger turnover.

The chairman quotes Board of Trade figures to show that in the year after the lifting of credit control the amount due on instalment transactions was up by 65 per cent. Such an increase in demand is not expected again this year but recent figures predict a slight increase of consumer demand this year on even the present high level.

The record of Bowmaker profits since 1953 is an interesting story of unbroken improvement not once interrupted by the vagaries of Government financial manoeuvre. From £384,778 in 1953 the annual profit rose year by year—£418,915 in 1954, £518,934 in 1955, £609,227 in 1956, £750,289 in the boom year 1957, £1,026,524 in the slight recession of 1958 and £2,303,851 last year.

Bowmaker have their headquarters on the coast at Bournemouth. Even there they have outgrown their present space and have adopted considerable expansion plans.

Rail Fortunes and Westinghouse

The narrow minded assumption that the substantial improvement in capital investment springs only from the businessman's post-election cheerfulness is sensibly amended by Captain Arthur Nutting, the chairman of the WESTINGHOUSE BRAKE AND SIGNAL Company.

No company is more deeply involved in the fortunes of railway development in this country and abroad. Since the British Railways had to cut back on their modernisation schemes, and since progress was not as rapid as looked for in India, Westinghouse was not able entirely to avoid some of the effects. Delivery dates in some large contracts were extended. There was redundancy in capacity and production became out of balance.

Another limiting factor, of which something has recently been heard from another direction, was the shortage of skilled signalling staff on the railways. This shortage slowed up the programme of resignalling and some of the Westinghouse signal and colliery division's capacity has been diverted to other products.

Despite these present difficulties Captain Nutting says in his annual statement that the year's trading was successful taken as a whole and that the group does not intend the results should be a peak. A broad scheme of capital development has been undertaken to fit the firm to meet the situation when the present high demand for some of its products may have receded.

In detail the group's brake division experienced a reduction in the acceptance against long term contracts of freight brakes. A high demand for locomotive equipment continued and there were substantial orders for electro-pneumatic brake equipment and compressors.

Orders for mechanical signalling and single line equipment, the main products of the group's railway signal company at Liverpool, continued falling and the company made a loss over the year. It is now actively negotiating for general engineering work.

SAXBY AND FARMER (INDIA) and GRESHAM AND CRAVEN INDIA, both at Calcutta, suffered from the falling off in the demand from the Indian Railways. But Westinghouse has confidence in the huge potential of the Indian sub-continent and is equipping its companies to be "fully competitive in this field."

The group trading profit for the year up to 3 October, 1959, was £2,557,488. The year before, which was one week less, it had reached £2,035,101.

25 years of Taylor Woodrow

It is something of a surprise to find that so large and well known a company as TAYLOR WOODROW Limited, the building and civil engineering contractors, have been a public company for only 25 years. They were so formed on 1 February, 1935, with the building of houses as their main concern.

The firm was founded in 1921 by Mr. Frank Taylor, (inset) now chairman of

the company, when he built two houses in his home town of Blackpool. Others followed and the firm reached the London area in 1930, erecting 1,000 houses in West Middlesex.

The first engineering contracts—as distinct from building work—were obtained in 1935, and airfields during the early years of the war gave the company the opportunity to expand as a civil engineering contractor. Later in the war Taylor Woodrow were engaged on such projects as the Mulberry Harbour, "Pluto" (pipeline under the ocean), and "Fido" (aerodrome fog dispersal scheme). Post-war contracts in the United Kingdom have included the civil work at Calder Hall and Hinkley Point nuclear power stations and the central buildings at London Airport. Overseas there have been the extension and reconstruction at Takoradi Harbour (Ghana), Nandi Airport (Fiji), and Port Harcourt (Nigeria). The company have also just won the contract for the road bridge over the River Niger to link Eastern and Western Nigeria.

Such is the growth of the company that their Press officer now boasts that he no longer impressed by contracts under £5 million.

Mr. Taylor claims that he personally introduced "public observation platforms" overlooking his working sites, thereby regularising what had previously been an undignified peering through holes in galvanised sheeting.

Positions all set in Aluminium Battle

Re-equipment and modernisation of JAMES BOOTH ALUMINIUM'S plant at Kitts Green, Birmingham, is to follow the purchase of a half interest in the company by the United States company KAISER ALUMINUM AND CHEMICALS.

In the £10 million scheme, £5 million is the contribution of the American company and £5 million that of DELTA METAL COMPANY by way of the assets of James Booth, a Delta subsidiary. Among these assets are the entire Kitts Green works, such significant trade marks as Duralumin, Dural, Aldural, Simgal and others.

The special strength of JAMES BOOTH AND COMPANY, whose assets were transferred a month ago by Delta to the newly named James Booth Aluminium company has been in strong aluminium alloys and in work for the aircraft industry. The participation by Kaiser makes it possible for the plant to go ahead with the installation of new rolling equipment for the production of sheet, strip and plate in pure aluminium and soft aluminium alloys. Sheet and plate widths will be as large as any at present being made in Britain.

The scope of James Booth will, when the new capacity is fully engaged, be expanded beyond the air industry to every form of transport including shipping, to building and the nuclear industry and to domestic goods.

Mechanisation

The effect, or lack of it, on the labour position is worth noting. Just as the BRITISH MOTOR developments at Longbridge are not expected to demand extra men so, because of "the fullest possible mechanisation" no strong increase in the labour force of James Booth is expected. There is of course greater security and prospects for those already employed in working for a more widely equipped and competitive plant.

The position of the British aluminium industry is now clear, both for competition between its parts and against other materials.

All four major North American aluminium firms have staked out an interest in Britain, an obvious entry into the Commonwealth and the British led European Free Trade Area.

Deployed

The set-up in Britain of the four American companies is:

REYNOLDS METALS. Buying a half share in 1957 in TUBE INVESTMENT'S aluminium division, the resulting company, Reynolds-T.I. Aluminium fought a successful battle early last year and bought BRITISH ALUMINIUM, then making a third of all aluminium products in Britain.

ALCAN. Full name, the ALUMINUM COMPANY OF CANADA, a subsidiary of ALUMINIUM LIMITED, has a long established outlet in Britain through NORTHERN ALUMINIUM, the British fabricating subsidiary of Aluminium Limited. Northern Aluminium also makes a third of United Kingdom aluminium products.

ALCOA. Full name, the ALUMINUM COMPANY OF AMERCA, having failed to buy British Aluminium fixed up a new company with IMPERIAL CHEMICAL INDUSTRIES to run the ICI's aluminium plant in South Wales. Alcoa have 49 per cent of the stock in this company, called IMPERIAL ALUMINIUM.

KAISER. The last to arrive at the party now has its half interest in JAMES BOOTH ALUMINIUM and some valuable connections and traditions.

Market reports suggest that consumption of aluminium in the UK last year had picked up on 1958, perhaps by as much as 15 per cent. Expansion in the coming decade, possibly with popular car firms following the lead of ROLLS-ROYCE in putting the engine block into aluminium, may mean the local offshoots of the American giants will be fighting for larger shares of larger markets.

Orderly Progress in Surface Measurement

A recent article argued that there was confusion in measuring surface roughness. Here, it is argued that orderly progress is being made and that surface measurements will become as simple as hardness measurements.

By R. E. Reason, A.R.C.S.

Taylor, Taylor and Hobson

Although the concept of roughness and smoothness is one that comes naturally to everyone through the eye and the finger, the estimation of their magnitude is peculiar to the individual, and difficult for one person to express to another without instrumental aid.

It is just 30 years since G. Schmalz, a German doctor both of medicine and of engineering, made the first attempts to study the nature of surface texture using a sharply pointed stylus to trace the profile and an optical lever system recording on photographic paper to display its movements. The problems of numerical assessment set by the generally irregular nature of the profiles were soon appreciated, and by 1936 Schmalz had reviewed the possibilities of measurement from the mean line, and from lines grazing either the peaks or valleys, and had given thought to their relationship.

In 1936, there appeared on the market the first direct-reading instrument having a scale and pointer; the "Profilometer" evolved by Ernest Abbott at the University of Michigan. This was an electrical instrument which converted the movements of the stylus into a corresponding alternating current and finally assessed the current representing the profile from its mean line.

The concept of the mean line—a reference line so positioned that the sum of the squares of the departures from it has a minimum value—is of great mathematical antiquity. Statisticians, often calling it the best line, make frequent use of it. There is probably no reference line better founded or more widely used for the assessment of fluctuating quantities. It enters especially into the behaviour of alternating electric currents.

Alternating electric currents have the property that in each cycle they flow first one way and then the other through the circuit, the magnitude of the current being zero at the moment of each successive change in direction. Alternating current meters measure the successive departures of the current from zero, generally on an integrated basis, and ignore the changes in direction either by their nature (e.g. hot wire ammeters) or by the use of rectifiers in association with direct current meters. If the variations in current are plotted against time, the line through the graph representing zero-current thus becomes the natural reference level from which alternating current meters automatically measure. It works out that this line is also the mean line (or best line of the statistician) defined on a least-square basis.

RESEARCH RESULTS

Recent research in the Taylor Hobson Research Laboratory, which has not yet been published, has produced simple explicit equations for the graphical determination of the position of the mean line.

A measure of the departure of the surface irregularities from the mean line of a sample of defined length has been the nationally accepted basis of surface roughness measurement in America since 1936 and in the UK since 1940. The measures first used were the root-mean-square value in America and the arithmetic average (CLA) value in the United Kingdom; the latter was eventually adopted in America in 1955, with the designation AA value.

In practice, the mean line system involves a little more than the mere observance of principle. To secure uniformity between one instrument and another, various instrumental characteristics have to be laid down, these being covered in the British and American Standards, BS 1134 and B46-55 respectively, which are identical except for some minor divergences now under review. There is a parallel for this approach in the instrumentation of hardness measurement where, although there are basic formulae of a general nature, the details of the indenter, the loads and their times of application may all have to be laid down and closely observed if repeatable results are to be ensured.

The CLA value, naturally, does not of itself completely specify even the geometry of the surface, because it is a measure of only one of the many geometrical aspects. Other geometrical aspects are for example the characteristic shape of the profile, the spacing of the crests and the bearing area after a certain amount of wear. However, even if these aspects could in some way be described by numbers and the burden of additional measurement were accepted by the workshop, there would still be left out of account a number of important metallurgical factors determined by the surface temperatures and stresses induced by the process of manufacture. The process can be significant, and may need to be specified, apart from geometry. Since it is found that the character of the irregularities is determined to a large extent by the process, it becomes possible to describe the quality of a surface in a simple and practical way by specifying the process in conjunction with a single controlling measure, which by widespread use is the CLA value. This simple approach—a plain statement of process with a controlling number—seems more direct than that of trying to write down a battery of numbers from which the process has to be deduced.

Confirmation of the ability of the mean line system to give useful control of surface quality was given by D. B. Ebsworth in a paper presented to the 1953 NPL Symposium on Engineering Metrology (*IPE Journal*, vol. 32, No. 12), describing how the system serves for the control even of the intricate sequence of processes necessary for the production of aero-engine cylinder liners. By now, the system has behind it the weight of 20 years of use in the largest user countries in the world, and a rapidly growing number of instruments and accessories. There is still, however, a need for instruments that will tackle even more of the small or awkward-to-get-at surfaces that come up for measurement, and to improve the extent to which commercial instruments as a whole adhere to the provisions of the National Standards.

Looking back, the history of the mean line system is one of orderly progress along practical paths. Looking ahead, there is a prospect of progressively improving instrumentation and of simple surface measurement becoming as everyday a matter as the measurement of hardness.

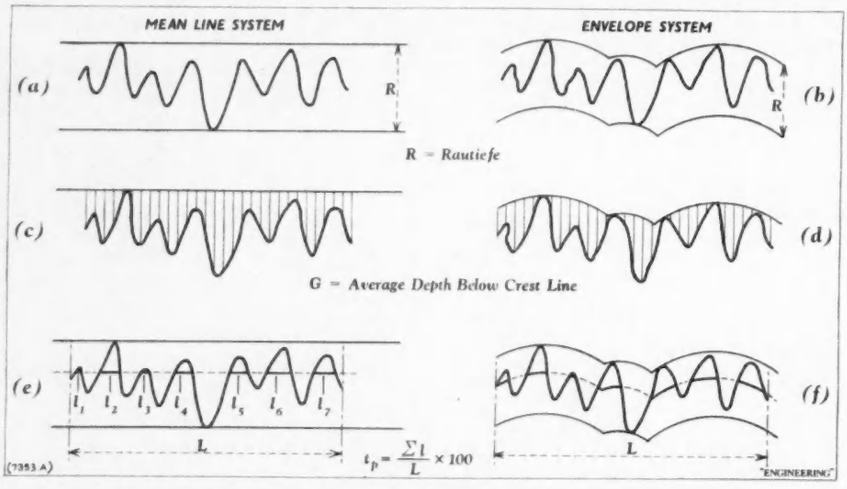


Fig. 1. Measuring surface texture by Rautiefe, Glattungstiefe and Traganteil.

It seems, however, that there are other ways of looking at the matter, and in ENGINEERING (23 Oct. '59, p. 393) Mr. M. P. Rubert writes of "Confusion in Measuring Surface Roughness." Certainly there is confusion on the Continent, where in several countries the history has not been one of orderly progress.

RAUTIEFE

In Germany, direct-reading instruments were little known even by 1950, and all normal industrial control was exercised through the medium of profile graphs. For speed of operation the practice grew up of assessing the total height of the surface texture from the highest peak to the deepest valley—the Rautiefe. German standards covering this form of assessment have received many modifications as the years went by. The definition of highest peak to lowest valley left open the question of how far apart along the surface the two might be. In one German standard (DIN 4760) this was answered in a somewhat cumbersome way by specifying a reference line averaging a specified number of the highest peaks coming within a sample of specified length, below which the deepest valley could be measured. The 1952 version accepted a reference line grazing the highest peak within the sample (see Fig. 1a). Then, in 1956, the reference line was defined in terms of the rolling circle envelope (see Fig. 1b). All these versions had in common the idea of picking out the deepest scratch; but since on the whole surface there can be only one deepest scratch, which will be included in the chosen sample only by the most remote chance, and since occasional deep scratches are often of no functional importance, the practice grew up of accepting or ignoring the deepest scratch shown on the profile graph at the discretion of the

inspector. Thus the Rautiefe became in practice a somewhat personal measure not lending itself to realistic instrumentation.

ALTERNATIVES

In addition to the Rautiefe, and perhaps because of the problems it presents, other measures have been considered, especially what is called the Glattungstiefe (the levelling depth or depth of smoothness) defined as the average depth of the profile below a reference line contacting the crests, the reference line being defined in the same varied ways as for the Rautiefe (Figs. 1c and 1d). Interest has also been taken in the Traganteil (Figs 1e and 1f) which purports to give a measure of the bearing area after a prescribed amount has been worn off the crests; but the amount of wear being generally specified in terms of the uncertain Rautiefe, this measure is again uncertain. It should be noted that the three terms Rautiefe, Glattungstiefe, and Traganteil appear in both the 1952 mean line and the 1956 envelope versions of the DIN 4760 standards, a source of confusion that is giving rise to considerable difficulty in discussing these matters.

Mr. Rubert's article itself makes some interesting and some confusing points. It is true that there has been much controversy on the Continent over the relative merits of the mean line and the rolling circle envelope as a reference line, and the letters M and E have appeared in papers on the matter, but it can hardly be said that they have been internationally adopted.

The suggestion is made that the use of the envelope system presupposes a graph recording with equal horizontal and vertical magnifications, but it could be pointed out (*a*) that the graphical construction for the rolling circle envelope is often applied to the usual horizontally compressed graph and (*b*) that, when the magnification is high and there is no compression, an impracticable length of paper is needed to portray a representative length of surface and the scale on which the enveloping arcs have to be drawn is prohibitive. On no scale does it seem possible to replace the arcs by straight lines.

EMBODIMENT OF THE ENVELOPE

As regards the embodiment of the envelope system in present day instruments, in which connection the author's name is mentioned, it is perhaps permissible to point out that he and his colleagues appreciated the theoretical possibility of choosing the locus of a rolling circle as a reference line, and commented on the instrumental difficulties of making practical use of it in the 1944 Taylor-Hobson Report on the Measurement of Surface Finish by Stylus Methods. Although modern magnetic recording methods could now be applied to combine correctly the signals from a separated skid and stylus, it is unlikely that this solution could lead to the evolution of the simple instruments for which the workshop longs. Certainly it is a fact that despite strenuous efforts on the Continent, starting as far back as 1953, a direct-reading envelope-system instrument has still not appeared.

On the basis of what little has been published on how the E and M systems compare, Mr. Rubert would seem right in saying that the adoption of the envelope line would be of little advantage to the practical engineer, and that there are other more urgent matters in need of consideration. As regards separation of roughness and waviness and errors of form, however, both systems offer this possibility, the mean line system by choice of sampling length, the envelope system by choice of radius of the rolling circle. For some reason the German envelope standard permits only two radii, namely 25 mm for roughness and 250 mm for waviness; this could be a troublesome limitation on flat surfaces where the actual length of the surface has sometimes to be taken into account, and an impossible one on concave surfaces of less than 25 mm radius.

Reference is made to the two surfaces reproduced in Fig. 2, for which it is said that the CLA

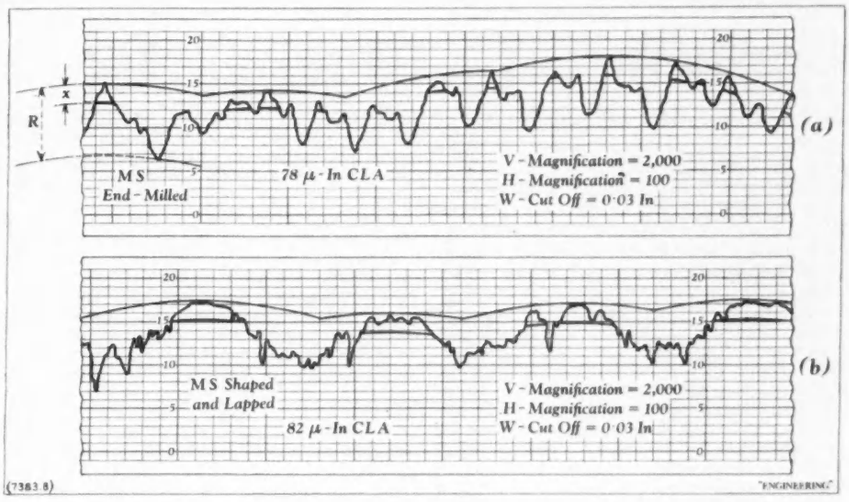


Fig. 2 Two surfaces giving approximately the same CLA readings. (See Table.)

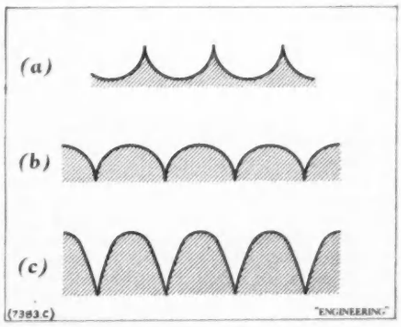


Fig. 3 (a) and (b) give the same CLA readings. (a) and (c) have the same G values.

readings are deceptive and further that the bearing area and depth of smoothness of (*a*) are only a fraction of those of (*b*). Now, these profiles are about equal in height and differ mainly in spacing which is 0·006 in for (*a*) and 0·02 in for (*b*). The crests of (*a*) are seen to be somewhat less rounded than those of (*b*), though they would look not so very different if the graph of (*a*) were stretched out to have the same apparent spacing. The length of graph displayed is shorter than would be desirable for the determination of the Glattungstiefe and Traganteil, but as far as the graphs permit the author finds that the G value is in fact slightly greater for (*a*) than for (*b*), while the Traganteil is appreciably less for (*a*) than for (*b*) only in the immediate vicinity of the crests (see Table).

TABLE

CLA	G_E	Traganteil for $\frac{x}{R}$ =		
		0·1	0·25	0·5
μ in 78 (a)	μ in 167	Per cent 11	Per cent 30	Per cent 70
82 (b)	140	27	45	72

The suggestion that the finger nail tells the truth about the surfaces in Fig. 2, and that the CLA instrument deceives us, is open to question. Which, if either, is deceiving us? The CLA value, for example, is a measure of the average height of the irregularities coming within the length of the sample, which is given as 0·03 in. The spacings of both profiles being less than this, and the profiles being roughly alike in other respects, one would expect to find about the same CLA values, which the instrument did. The nature of the CLA measure being understood, there was no deception. The fingernail, on the other hand, takes other aspects into account; it tells us that the frequencies and accelerations generated by (*b*) are less than those coming from (*a*). All things being equal except the spacing, the finger always prefers the wider spacing. Whether wider spacing (for a given height) leads to more or less wear is another matter that cries aloud for continued study following the work of Robinson, d'Souza and Salama, who in the Manchester College of Technology, showed that widely spaced waves could help to build up oil wedges and increase the load carrying capacity of a thrust bearing.

In contrasting the well known profiles shown in Fig. 3, which have the same CLA value but quite different functional qualities and G values, it must be realised that the CLA value is best used as a monitor of a stated process, and that the process or combination of processes that produce 3a would be unlikely to produce 3b, so that the equality of CLA values is not likely to be as misleading as is often thought. Further, the substitution of the G value as a single index would not solve the problem: Fig. 3c has the same G value as 3a but is still not functionally equal to it.

CONVERSION

Mr. Rubert discusses a conversion factor between Rautiefe and CLA, based on some interesting readings obtained with the Perth-O-Meter. These readings would suggest that there is a usefully close relationship, provided the process is stated. However, two comments can at once be made. Firstly, if there is a usefully close relationship it will suffice to measure the CLA value, and arguments about the importance of Rautiefe are of no substance. Secondly, the finding that the ratio is the same for ground as for lapped surfaces (on the latter of which occasional deep scratches leading to very high ratios are often found) suggests that in measuring the Rautiefe, the Perth-O-Meter does sometimes ignore the deepest scratch and in this respect does not perform strictly in accordance with any of the German standards. It would have been helpful is something had been said about the performance characteristics of this instrument.

It is to be hoped that expense and confusion resulting from the use of what is ultimately seen to be a needless multiplicity of measuring systems having much the same sorting power will be avoided.

The paper pulp mill described in ENGINEERING (22 Jan. '60, p.126) is at Catawba, South Carolina. This was made quite clear in the text, but we regret that the title referred to California.

Control of Stocks by Simple Rules

Raw material stocks tie up a lot of capital. How much stock should be held? In a specific case, £100,000 of working capital was released by reducing stocks, and production was kept at the required level.

By R. H. Collcutt, B.Sc. (Eng.), Head of Operational Research Department, British Iron and Steel Research Association

In most industries stocks of raw materials are a necessity, the main purpose of stock being to ensure that production is never, or hardly ever, held up for want of raw material. But the drawback with any form of stock is that it ties up a fair amount of a company's working capital; in industries such as steel the high value materials used make this an especially important point. Therefore the problem is how much money should be put into material stock, and this also poses the related question "How often would production be held up with various levels of stock?"

A particular problem of this nature has been tackled by the Operational Research Department of the British Iron and Steel Research Association for a company which was obliged to use two stock areas. One was near to the works and the other some distance away. The result of this arrangement was that two lots of handling equipment were necessary, and furthermore the cost of transporting raw materials from the more distant stock area had to be added to the capital tied up in the stock. The particular problem then, was "Can we reduce our stock levels to a point where we can dispense with the more distant stock area (and its associated equipment and labour) and, by so doing, reduce the capital invested in our stock and also save the transport costs?"

INVESTIGATION

The initial step was to ask "How does the company order and control its stock at present?" It was discovered that, roughly speaking, the company ordered a fixed total quantity of stock each week, but that the quantities of each of a number of grades varied from week to week, according to production requirements. Superimposed on this method of ordering was a policy of "We're getting low on Type A steel—we'd better order more." The combined effect of these methods was to cause the stock to fluctuate between 2,000 and 9,000 tons, with an average of 5,400 tons, as shown in the accompanying graph.

The objections that can be raised to this ordering procedure are that the control of the stock level is not strict enough; that the method of control is too haphazard; and that the method of ordering does not take into account the character of the deliveries following the placing of an order. It should be explained here that there is little or no likelihood of delivery in the seven days following the placing of an order for steel; the major part of the order will probably arrive during the second and third weeks after the date of ordering and the remainder will be spread over the fourth and fifth weeks.

The technique which was used to solve this problem is known as simulation; the main features of the existing pattern of production of the company, and of the characteristics of delivery of raw materials, are closely examined over a period and then (using a manual method or a computer) a production programme is constructed for a complete year, or other suitable period. Subsequently the week-by-week effects of several different methods of ordering and controlling stock on the production programme can be tried out, each trial yielding the stock level appropriate to the order and stock control method used. Nevertheless, there is no justification of imputting regularity to the pattern since orders for the finished product arrive in a random and unpredictable way, and, similarly, the deliveries of steel following an order are also haphazard. However, the technique includes the introduction of randomness into the reconstructed production programme, so that the programme used for the simulation is just as likely to occur as an actual programme. The same argument is applied to the deliveries of steel; the simulated deliveries are just as likely to occur as actual deliveries.

It must be stressed at this point that the methods of ordering and controlling stock tried out in the simulation of the operations of the works are themselves derived from a study of previous practice. Moreover, if it is felt that the adequacy of any given set of rules is not sufficiently proved by following up its effects on the production programme over one year, the simulation can be extended to any desired length of time.

SOLUTION

The ordering rules finally developed and recommended to the company were:

(1) The "normal" weekly order for a particular grade of steel should be regarded as the average weekly consumption of that grade.

(2) This "normal" weekly order should only be varied when the total production scheduled for the next two weeks exceeded the total of the amount held in stock plus half the amount outstanding on orders placed during the previous weeks.

(3) If the condition in (2) applied then the normal weekly order should be increased by an amount equal to twice the deficit.

(4) If the forecast production requirements for the next three weeks were less than the stock plus half the total outstanding on orders not completed, only the "normal" quantity should be ordered.

(5) If the total amount of a certain grade held in stock was equal to a predetermined level, then no more of that grade should be ordered.

These rules were chosen from the results of analysing the previous experience of the company, when it was found that:

(*a*) The requirements of production were known very accurately for at least two weeks ahead.

(*b*) That there was a very good chance (95 per cent) of at least half the order placed today being delivered in the next two weeks.

(*c*) That at any time at least half of any outstanding amounts on orders placed earlier could be expected (95 per cent likelihood) to be delivered in the next two weeks.

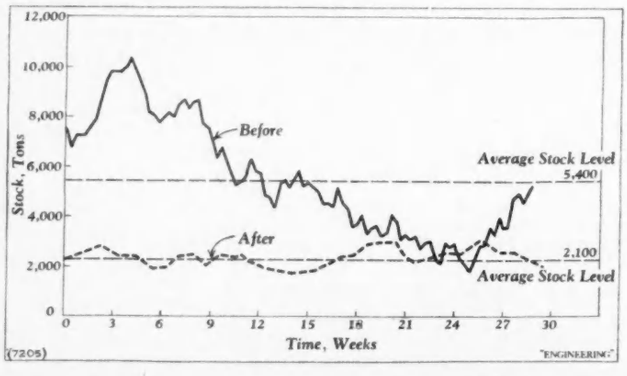
These facts explain (for the rules recommended) the choice of the two-week period, the figure of half the outstanding orders, and the placing of orders of double the amount required to cover any deficit in stock to meet the next two weeks' production. The figures of ½ and 2 in these rules would, of course, have to be changed if the material supplier changed his ways of honouring an order: a constant check should be kept for such a trend, although, since a review of order quantities is to be made weekly, the ordering rules can cope with quite considerable variations before their effect on the control of stock levels would make themselves felt. The rules, it will be evident, are simple and operating them well within the capabilities of normal clerical labour.

SAVINGS

The resulting stock fluctuations brought about by the rules given are shown in the graph. The total stock remains well below the 4,500 tons limit set by the amount of room available; in fact during the experiment it never exceeded 3,100 tons. Clearly, then, the method of control was effective.

Although during each year's simulated working the production had never actually been curtailed, there were four occasions when orders had to be postponed for a week owing to shortage of a particular grade of steel. This amount of dislocation of the production programme was acceptable to the company.

At this point it is appropriate to stress the fact that this system of rules is not necessarily the best in an absolute sense; it is merely a much better set of rules than had been in use in the company previously. In practice it is almost impossible to devise the optimum set.



Stock levels before and after control. In addition to reducing the capital tied up in stock, the revised stock level enabled a second stockyard to be closed down thereby cutting labour and transport costs.

The actual savings resulting from the solution of the particular problem mentioned above were the release of £100,000 of working capital, achieved by reducing the average stock level from 5,300 tons to 2,100 tons and, on top of this, about £6,000 per annum obtained from the difference between the cost of redesigning the stockyard, buying new equipment, etc., and the saving obtained by selling old equipment and reducing labour and transport costs.

This level of saving in a relatively small company producing about 1,200 tons of rod per week, represented a very substantial addition to their profit margin.

REFERENCE

R. H. Collcutt, J. Banbury, R. G. Massey and R. A. Ward, "A Method of Fixing Desirable Stock Levels and of Stock Control," pp. 81-95, *Operational Research Qtly.*, vol. 10, No. 2, June 1959.

Warm Air For Starting Jet Aircraft

The "Air Partner" portable pneumatic starter for aircraft, a product of the international Atlas Copco organisation, is finding increasing use with a number of well-known airlines, including SAS, Canadair, KLM, South African Airways and Air-India. It is distributed in the British Isles by Atlas Copco (Great Britain) Limited, Hemel Hempstead, Hertfordshire.

Mounted on a motor lorry chassis, the unit consists of a screw rotor type compressor, which has a normal between-overhaul life of 10,000 hours. It delivers a supply of compressed oil-free air, warmed by compression, through a flexible hose, which is coupled to the nose connection of the aircraft. This air is used to drive small, high-speed compressed air turbines geared to the jet engines of the aircraft. The air is hot enough to promote easy starting, but never reaches a temperature which could endanger the interior ducting of the aircraft. As the unit is capable of turning the engine continuously, it can be used for work such as oil pressure checking.

In addition to engine starting, the "Air Partner" can serve as a ground air-conditioning unit. In less than an hour it can heat up the aircraft cockpit from below freezing point to the desired travelling temperature, or it can cool the interior to a suitable temperature after ground exposure to tropical sun.

With a special ejector pipe mouthpiece on the delivery hose the unit can be used for manual hot air de-icing of the wings and fuselage. Removal of ice from the windscreens, main plane leading edges and air-intake lips is done by operating through the usual nose connection and the aircraft's own de-icing outlets.

Warm compressed air is supplied by the Atlas Copco "Air Partner" for engine starting, air-conditioning and de-icing.

Automation for Missiles on the Battlefield

It is no simple thing to replace artillery by ballistic missiles. Operational rockets call for instrumentation and data processing on a scale unheard of on any battlefield. Each ballistic missile launching unit needs its own laboratory to test the complex control and guidance assemblies before firing. On permanent sites this can be arranged without a great deal of difficulty. But over the changing terrain of a battlefield, considerable ingenuity will be needed to provide the complete unit with mobility and reliability.

Some details of the ground equipment associated with the United States Army's Sergeant missile have recently been released. The missile itself measures some 34 ft by 2½ ft in diameter and has a range of 150 to 200 miles. Ground handling problems are simplified by its use of a solid propellant. It follows a ballistic trajectory, so accurate computation taking into account air densities and temperatures, is necessary to establish the initial path of the rocket for impact on a given target.

The US Army ballistic missile support units are of two types: a test station close to the front-line launching site, and another testing station held well back from the line. The first tests the individual assemblies in the missiles and replaces the faulty assemblies with new ones. The second accepts faulty assemblies from the front line unit and tests the individual sub-assemblies, replacing faulty ones and returning the operating assembly to the front line. Defective sub-assemblies are returned to factory. One assembly is concerned with one function in the rocket.

The various parts of the rocket and the testing station are carried on four-wheeled trailers that couple on to large six-wheel towing vehicles. Each test station travels on its own trailer, while each missile requires two trailers—one carries the engine and guidance section—the other two standard warhead sections. Normally, other vehicles operate between the forward and backward stations, transporting new missiles and assemblies.

The launching equipment for a rocket also travels on its own trailer, together with a firing cab. Weighing about half as much again as the missile itself, the launching unit is in the form of a boom connected to a pin-jointed parallelogram. Hydraulic jacks acting along the diagonal of the framework open and close it.

The unit is self-loading. An electric hoist operating within the boom connects the parts of the missile to the boom and to each other. Slewing and elevation movements are controlled hydraulically and are made automatically on the setting of the required coordinates. The computer for evaluating coordinates and controlling the launcher movements is located in the firing unit mounted on the same trailer. The unit also provides automatic count-down and monitoring.

Before firing, tests are made by the test unit to see that assemblies in the rocket are functioning correctly. Construction of the test equipment follows the same package principle used in the missile itself, plug-in components being used throughout.

For testing, comparison methods are employed. These are based on standard voltages and timing waveforms generated by the test unit. Testing of the missile assemblies is carried out automatically in accordance with instructions on punched tape. Once the process is initiated the assemblies are tested one by one in sequence. When a defective assembly is recognised an indicator lamp flashes.

Each assembly is identified by the test unit by measurement of a characteristic resistor within the assembly. If the resistor is not identified the test programme will not be carried out. This ensures that the correct test programme is applied to the correct assembly. The test unit also tests itself and has duplicate standby units.

Standard voltages are derived from a modified form of Wheatstone bridge with Zener diodes. This provides a voltage of 8V $\pm$ 0·4mV. A built-in voltage divider produces all intermediate voltages required. Timing pulses originate from a 1 kc/s transistorised crystal oscillator. Temperature sensitive elements in the unit are housed in a thermostatically controlled oven.

The evolution of such automatic testing equipment for operation under battlefield conditions is a considerable achievement. It is also an indication of the manner in which automatic testing could be developed to industrial ends. The complete missile system was produced by Jet Propulsion Laboratories in conjunction with the Sperry Rand Corporation.

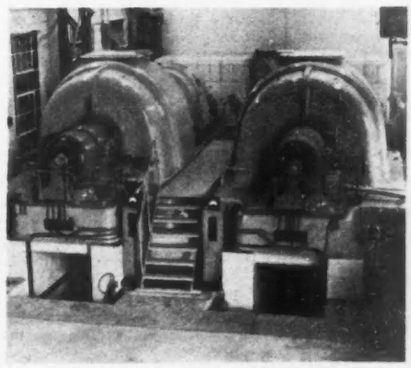
Testing Bigger Transformers

Because the general trend in electrical transformers is for the size to increase, larger-capacity testing equipment is becoming necessary. This need has been met by the Hackbridge and Hewittic Electric Company Limited, Walton-on-Thames, Surrey, by the installation of a pair of identical motor-alternator sets, with the necessary step-up transformer and ancillary apparatus. With this equipment the company now have available a nominal capacity of 30 MVA at any voltage from 20 kV to 50 kV at any power factor from 0·1 to 0·01. This means that a full-load short-circuit heat run can now be carried out on transformers up to approximately 200 MVA. As the driving motors are of sufficient capacity, it is possible, with the addition of capacitors across the alternators, to test even larger transformers under full current conditions.

Each motor is a 2,000 h.p., 1,500 r.p.m. synchronous machine with two pedestal bearings and a direct-coupled exciter, and is arranged for auto-transformer starting. A vernier type coupling is used between the motor and alternator to allow of physical phasing.

There is a common lubrication system for both sets; this includes a 750 gallon sump tank with thermostatically controlled heaters and a water-cooled heat exchanger.
are included to heat and circulate the oil through the bearings before starting and to cool it when the units are running. Interlocks prevent the starting switch from operating unless the jacking pumps and main oil pump are running. A battery set provides power for the oil pump motor in case of current failure.

The transformer has three secondary windings per phase, two arranged in series-parallel, while the third is a tapped winding; the latter has a capacity of 900 amps and the former are of 450 amps each. With this arrangement, any voltage from 20 kV to 50 kV can be delivered in 2·5 kV steps.



Two motor-alternators at Hackbridge and Hewittic Electric Company for testing large transformers.

On the Shelf

By Frank H. Smith

The Iron and Steel Institute information side goes from strength to strength, as one would expect iron and steel to do in these enlightened days of research. Here is another pearl (if one may thus mix the metaphors).

Their latest idea is an "advance" service of abstract and book title index cards. These are 5 in by 3 in cards, each covering one of the 750-odd abstracts that appear each month in the *Journal*. But the issue will be ahead of the *Journal's* publication and will be fortnightly. Full particulars are obtainable from the I. and S. secretary at 4 Grosvenor Gardens, London, SW1, but the nub of the matter is £90 a year for abstracts, 90*s* a year for book titles, each of which carries a 33⅓ per cent reduction for members. To save slide-rule hunting these rates are $252 and $12·60. I suppose this gun-beating has its uses but for my money the great advantage is in the 5 by 3 cards. One other small point: reckon on 9,000 abstract cards and 500 cards for books per year. Then go out and rent a new building.

I understand that last year men in America spent more money on cosmetics than did women in America. Now that you see which way the wind is blowing (and you should be able to use your sense of smell as well), bear in mind that *Cosmetic Science*, the papers of the 1959 congress organised by the Cosmetic Chemists of Great Britain, are available from Butterworth at 60*s* for the 342 pages. I see that one paper dealt with corrosion of iron and aluminium, so if you drop some after-shave lotion on your razor and the thing disintegrates—don't try it on your chin. Hiya, faceless!

In the Snowy Mountains Hydro-electric Authority (down under) they have difficulties in finding trained man-power. Their methods of overcoming this shortage with the not-so-skilled is described in "The training and use of sub-professional staff" in the *Journal of the Institution of Engineers in Australia* for October-November, 1959.

It might be worth your while asking Wm. Dawson and Sons Limited (16 West Street, Farnham, Surrey) for their wants lists, numbers 22 and 23. These give periodicals for which they have firm orders and include such distinguished items as ENGINEERING, 1959, complete. This is already a collector's piece in view of the inclusion of a certain column.

New journal. *International Journal of Heat and Mass Transfer*. Price, see overleaf and overleaf it says £7 or 5 guineas depending on whether you are a body or an individual. For further information try Pergamon (4 Fitzroy Square, London, W1).

The Magazine of French Production (8 rue de la Michodière, Paris 2e) is in English and the only one I've seen is No. 34 (fourth quarter 1959). It is, of course, aimed at boosting French products and makes quite a good job of it.

An aggressive looking rooster decorates the cover of number one of *I.C.T.*, if that is the title, but there's also a bit about Hollerith and Powers-Samas equipment so that you do not know whether it is a catalogue or a magazine. I favour the latter, and if you want to see a copy, I.C.T. Limited are at 17 Park Lane, London, W1, and telephone number HYDe Park 8155.

As of 1960 *Computer Bibliography* becomes *Computer Abstracts*. Union list compilers please note and tear hair accordingly.

The *Journal of the Institution of Production Engineers* is now *The Production Engineer*.

Now that you have had a chance to think about it, what is your opinion of the new look ENGINEERING? Drop me a line if you are afraid to tell the Editor and I'll pass it on. There is no truth in the rumour that this column is to be micro-reproduced with a free reader in return for 200 corners snipped from the cover.

Bearings and Bearing Surfaces

Betriebssichere Gleitlager. By GEORG VOGELPOHL. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (46·50 *DM*)

It is now generally accepted that plain bearings should be designed so that the parts subject to relative motion shall be supported on fluid pressure films generated by the induction of the lubricant through converging passages formed by the surfaces themselves. In the case of journal bearings, the converging passage is created by the shaft taking up an eccentric position within the bearing bore and in the case of thrust bearings, the tilting pads introduced by Michell are an artifice designed to produce the same result. Simple as is the principle underlying fluid film lubrication, its application in design so as to assure successful and economical bearings is complex. Indeed busy designers, to whom the bearing is but one of many details which go to make up a machine, have seldom time at their disposal to determine the proportions of their bearings in accordance with hydrodynamic principles, and rule of thumb methods based on previous experience are frequently employed. Hydrodynamic theory permits considerable freedom to a designer and such estimates are usually satisfactory. They do not provide a sound basis for generalisation, however, and offer little guidance towards the most economical solution of a given bearing problem.

Several texts have appeared recently which expound rational methods of bearing design and Professor Vogelpohl's contribution may be regarded as the definitive text outlining the classical German approach. After a meticulous presentation of basic data on the properties of lubricant, experimental and theoretical work on bearing performance is analysed and coordinated so as to provide the basis for design. The effect of bearing clearance is discussed from the point of view of obtaining the maximum film thickness. The eccentricity at which a bearing will operate is determined by the speed, viscosity, load and clearance. If clearance is made very large, eccentricity will be high so that the thickness of the film at its thinnest point will be low. Similarly if clearance is made very small, the bearing will operate with little eccentricity, but film thickness will be small because, of course, it will be limited by the clearance. There is clearly an optimum clearance that will result in the maximum thickness of the oil film at its thinnest part. Expressions are given enabling this optimum to be calculated for the half bearing and the result may be expressed approximately by the statement that the amount of clearance should be so selected that the bearing operates at an eccentricity ratio (eccentricity to radial clearance) of 0·5.

The criterion of safety adopted by the author is "the smallest permissible film thickness." This must depend on the roughness of the components, their departure from theoretical form and the degree of alignment of the shaft within the bore. The relative importance of these factors is discussed and the author concludes that roughness is of predominant importance. When speed is given in revolutions, permissible load varies as the product of the length of a bearing and its diameter squared. Vogelpohl uses this fact to introduce the volume of the bearing in a very simple way, as evidenced by the following expression: $p = C\,\eta\,n\,\mathrm{Vol}$,
where p is the maximum permissible load; C is a constant which varies from 1·07 to 6·4 depending on bearing material, method of machining and method of introduction of lubricant; η is viscosity of lubricant; n is speed of rotation; and Vol is the volume of journal.

Having ensured that a bearing will generate a sufficient film to support the load, it is then necessary to ensure that it will not overheat. Indeed, an estimate of the operating temperature is necessary to determine the value of η to be introduced in the above expression. Methods for calculating the various ways in which heat may escape from a bearing are discussed, together with a graphical solution of the problem of determining operating viscosity.

The work concludes with a discussion of hydrostatic bearings: for example, bearings in which the pressure in the film is supplied by an external pump, a principle which is now topical due to its application on an enormously increased scale to the Hovercraft.

All the topics dealt with in the book are very fully illustrated with detailed fully-worked examples. The work perhaps needs amplification to enable designers to deal adequately with such problems as engine bearings wherein load varies rapidly in magnitude and direction, or very high speed bearings where whirl may be a problem, and most of the bearings illustrated appear to be rather wider than would be encountered in advanced practice in this country. Nevertheless, the author has succeeded in the object he sets himself, namely, exposition of the means of ensuring that bearings are so proportioned as to operate safely in service.

Wälz-Bohrreibung. By WALTER WERNITZ. *Friedr. Vieweg and Sohn, Burgplatz 1, 20b Braunschweig, Germany.* (12·80 *DM*).

Where rigid curved bodies are forced together, the stress acting in the region of contact is not calculable by the methods expounded in most books on "strength of materials," but can be estimated on the assumption that the stress and deflections in the immediate vicinity of the contact are of predominant importance and that stresses and deflections remote therefrom can be ignored. That is, the components themselves are regarded as being semi-infinite in extent. The expressions employed for estimating stress distribution and deflections in the contact zone derive from the equations of Hertz and contacts of this type are known as Hertzian. For many years, the only important engineering component to be treated from the Hertzian standpoint was the rolling contact bearing, but the importance of this form of stressing is now exciting the attention of many engineers, for example, those concerned with gearing and with the behaviour of wheels on rails.

Hertz's equations treated the case where the bodies were pressed together by normal forces alone and the distribution of compressive stress could be represented by the ordinates of a semi-ellipsoid constructed on the interface of contact. When tangential forces have to be considered, the problem is very complicated, not only will the tangential tractions affect the stress distribution, but in practice they will only be transmitted by frictional force. Thus the tangential stress distribution will be governed by the product of local normal pressures and the coefficient of friction and, in some parts of the area, this product will be of insufficient magnitude so that sliding may occur over part of the area while a "grip" is maintained over the remainder. The calculation of the frictional restraint in these circumstances thus presents a very difficult problem in applied mathematics.

Numerous infinitely variable drives are now available in which the torque is transmitted through Hertzian contact and this has presented an acute need for means whereby the frictional losses may be calculated with precision.

The author describes a number of frictional drives which serve to emphasise the importance of the topic as well as demonstrating the prevalence of situations wherein the rolling element is required to execute motions having a component of rotation about an axis at right angles to the general motion of rolling. As an example, we may consider a deep groove ball bearing. When such a bearing is subject to radial load only, the balls rotate about an axis parallel to that of the shaft and the situation is a comparatively simple one. However, if an axial load is applied, the bearing becomes effectively an angular-contact bearing and the balls rotate nominally about an axis whose direction is governed by the angle of

contact. This introduces additional frictional forces tending to resist twisting or spinning of the balls relative to the raceways, the calculation of which is the main subject of the work.

Assuming a value for the coefficient of friction, the frictional moment acting on an element may be estimated by calculating the position of a "pole" which is offset from the centre of the zone of Hertzian contact. In our terminology, we would speak of the radius of the friction circle. A well produced chart is appended to the work which gives a non-dimensional polar offset $(1/\sqrt{ab}$ where 1 = polar distance and a and b are the semi-axes of the ellipse of contact). The ordinate is the Hertzian auxiliary angle expressing the degree of curvature of the two components.

Three sets of experimental results are given; firstly, a preliminary series of tests wherein a ball was rotated in a cup, secondly when a curved member rotated in an internal groove of a larger member, and finally, cylinders of various diameters were run together. The effects of load, speed and lubricant were investigated. The theory is also applied to Lane's results on the two-ball machine.

A bibliography is given but there appear to be notable omissions therefrom. The early work of Poritsky, Hewlett and Coleman on pivot bearings would appear to be relevant and a study of the contribution of Johnson might have been helpful to the author in his work. The work will be of use to engineers concerned with mechanisms embracing moving elements in Hertzian contact and may stimulate farther inquiry into the difficult problem of analysis of the forces, movements and elastic strains involved.

F. T. BARWELL

Radioactive Tools

The Use of Isotopes: Industrial Use. Volume 19 of the Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy. *United Nations New York; HMSO, London.* (89*s*)

This volume records the papers, read and unread, and the discussion of them, presented by 18 nations at two technical sessions of the 1958 Geneva Conference. The preface reminds us of the vast number of papers prepared for the conference and of the need for a programme divided into five parallel series of sessions. The preparation of this edited version in English is a remarkable feat—the more so for the very few blemishes in the text. An unfamiliar, if logical, example of the perils of translation occurs on page 95 where the expression ". . . braking-effect X rays . . ." is to be found. The presentation is generally excellent—with a high standard both in printed text and in the blocks for the diagrams—and most papers are well stocked with references to other work.

The titles of the two sessions are a little misleading—necessary as the division may have been in a conference with one eye on the clock and the other on Geneva's superb restaurants. In this single volume the title could well have been a combination—Progress of the Use of Isotopes in Industry: for these papers largely restrict themselves to industrial applications with emphasis on progress since 1955 rather than on fundamentally new approaches. The line between research and application is in places rather tenuous but the exclusion of papers concerned with the production of radioisotopes and of their use for medical therapy is almost complete.

Of the 53 papers included, some 30 are primarily concerned with one or other application of radioactive tracer technique. A further dozen deal with measurement and process control apparatus involving relatively small closed sources. Thus four fifths of the papers record extensions of known techniques, albeit in some cases to fresh applications. Among the latter are a relatively large number concerned with one or more stages in the metallurgical art; from problems of ore crushing and mixing to tracer examination of the core boundary conditions in continuous casting and autoradiography of grain migration at boundaries in alloys. Many of these papers come from the USSR.

Increasing importance is attached to the use of tracer techniques in the wood pulp countries, in chemical engineering process control, and in the study of soil mechanics, subterranean water movements, coast erosion, and siltation.

Alongside the metallurgical applications is evidence of considerable interest in non-destructive testing and other aspects of radiography. This subject, as applied to thin layers, has, together with various process control techniques, led to an increasing interest in the use of low energy sources and of back-scattering techniques. Such new source development as is discussed is largely devoted to this aspect of the work.

There are, as is customary, some papers dealing with the industrial economics involved in the use of radioactive isotope techniques—although practically nothing is said of the economics of their production. While this is not unimportant for small sources—it may be that for very large irradiation processing sources the cost of production is a vital factor. On the other hand it can be argued that it is early yet to worry too deeply until several pilot scale operations have been carried out. Both USA, UK, USSR, and France have revealed plans for such large-scale uses but singularly little reference to them is made in the papers of this volume. The economic advantages of the use of the small source techniques is, however, discussed in part or in whole in some eight or ten papers. The conclusions indicate substantial savings in both dollars, roubles and pounds (of the order of 10^6, 10^6 and 10^6 respectively) even though, for example, it is stated that only 10 per cent of US industry has so far been interested.

Three isolated papers may perhaps point the way to really new lines of research and development affecting future industrial applications. They concern the effects of radiation, the direct conversion of radiation energy to electrical power (albeit on the scale of a few watts only) and the use of nuclear explosions peacefully for the production of active material.

This then is the broad impression of the volume—much consolidation has taken place—many techniques appear to be paying-off. There are some exciting new ones and all the nations who contributed are putting over all the information they can. Some may have been prompted to overstate their case for propaganda purposes but by and large the impression is of pride in achievement.

E. R. WIBLIN

Ultra Cold Techniques

Cryogenic Engineering. By RUSSELL B. SCOTT. *D. Van Nostrand Company.* (42*s*)

The possibilities opened up by the use of low temperature technology have as yet scarcely begun to be exploited. At the present time the only such large-scale process in this country is the production of oxygen and nitrogen by the fractional distillation of liquid air. There is little doubt, however, that an increasingly large range of applications will become of importance, as for example, in the provision of more efficient fuels for long-range rockets, in the separation of deuterium from hydrogen, and in the more general fields of chemical engineering and the use of superconducting circuitry in electrical engineering. Mr. Scott's book provides an admirable account of the special techniques which have been developed over the last fifty years or so, for producing and handling temperatures in the range from −183° C (or 90° K, the boiling point of liquid oxygen) down to and below 4·2° K, the normal boiling point of liquid helium. It is, as far as I know, the first book to be written on this subject from the point of view of the engineer rather than the research physicist.

Mr. Scott's own experience in this field gives him an almost uniquely favourable position for his task, and he has made good use of it. He has been on the staff of the Low Temperature Section of the United States National Bureau of Standards for 30 years, and since 1952 has been in charge of the Bureau's Cryogenic Engineering Laboratory at Boulder, Colorado. There is probably no other laboratory in the world with comparable facilities for the large-scale study of materials and processes at the lowest temperatures, and Mr. Scott's account of some of the latest developments makes fascinating reading. The book opens with the methods used for attaining low temperatures, namely by the liquefaction of air, hydrogen, and helium, in order of descending boiling points, and the relative merits of the various liquefaction processes are discussed critically. While intended for the reader unfamiliar with low-temperature techniques, a basic knowledge of thermodynamics is expected. To the cryogenic engineer the account of the various types of heat exchanger and the appropriate methods of calculating their efficiencies is particularly useful. An interesting detailed description is given of the large hydrogen liquefier in operation at Boulder, which has an output of over 300 litres per hour of liquid hydrogen.

A section on the separation of gases, which includes recent work on the use of a rectification column for the production of deuterium (or more strictly, hydrogen deuteride) from hydrogen, is followed by a short chapter on the adiabatic demagnetisation technique for the production of temperatures below 1° K. Here the author has resorted entirely to qualitative explanations of the method, and greater clarity could have been achieved in very little extra space by use of the appropriate thermodynamic formulae. Low-temperature thermometry is dealt with thoroughly, and there are excellent chapters on methods of thermal insulation, including a useful brief description of the necessary high

Continued on next page

vacuum techniques, on storage and transport of cryogenic liquids, and on the transfer of these liquids through insulated pipes and valves. A fascinating account is given here of a scheme for cooling the copper coils of a large electromagnet with liquid hydrogen, in which preliminary work showed the feasibility of using an ordinary commercial water pump for pumping liquid hydrogen at a rate of over 100 gallons per minute. The chapter on storage gives useful calculations of the relative merits of various methods of insulation for liquid hydrogen and helium.

The final section of the book is devoted to a full description of the physical and mechanical properties of the four cryogenic fluids, liquid oxygen, nitrogen, hydrogen and helium, and of the various structural materials used in cryogenic engineering. It includes a large number of useful tables and graphs, many of them containing information not readily available in any other handbook, and therefore valuable, not only to the engineer, but also to the research physicist. A slight criticism here is that the American specification of certain alloys is largely meaningless to the British experimentalist, so that a table giving the composition of all the alloys mentioned would have been helpful.

Each chapter contains full references to other original sources, and the book is furnished with the usual subject and name indexes, both of which are quite adequate.

J. M. LOCK

From Ore to Reactor Fuel

Uranium Ore Processing. Edited by JOHN W. CLEGG and DENNIS D. FOLEY. Prepared under contract with the United States Atomic Energy Commission *Addison-Wesley Publishing Company, Reading, Massachusetts.* ($7·50)

Uranium was discovered over 150 years ago, but its minerals attracted little commercial attention on account of their uranium content before the Second World War. Then, quite suddenly, it was needed in pure metallic form as "fuel" for thermal reactors to produce plutonium for military purposes. Several years later a great interest started to develop throughout the world in uranium reactors as power producers and now some thousands of tons of uranium are extracted annually for the development of this modern industry.

Initially, all requirements could be met from rich deposits of pitchblende, but it was readily apparent that these had a very limited life. Attention was directed, therefore, towards extraction from gold mining residues, and widespread geological surveys were started, which identified many low-grade deposits in various territories. However, from the point of view of those responsible for extracting the uranium there were considerable problems, since instead of using pitchblende concentrates containing over 50 per cent uranium, they had to start from a wide range of minerals, some of which were very difficult to open up, and frequently contained less than 0·1 per cent uranium.

In the volume under review, *Uranium Ore Processing*, methods are described which have been developed for mining, physical beneficiation, extraction and purification of most workable uranium deposits. Each subject is treated in considerable detail, a good balance being maintained between theory, technical data and descriptive matter in the earlier chapters. Two chapters discuss specifically the theory, application and plant requirements of operations which are relatively new to field operations—ion exchange and solvent extraction. Later chapters are devoted to comprehensive descriptions of the world's (excluding the USSR) major producing units and include a wealth of flowsheets and plant flow diagrams. A final chapter considers briefly the health and safety problems associated with the early stages of winning uranium.

The technical content is consistently high, which is not surprising since each chapter has been written by contributors who have been intimately associated with the overall project in the USA, and have actual experience of the special aspects with which their chapter deals.

An excellent list of references appears after each chapter. Although these are drawn from world-wide sources they are predominantly American, and as such give some indication of the very great amount of technical effort put into the subject by the USA. It is unfortunate, however, that fuller reference to British work could not have been included, thereby indicating the considerable contributions made by this country to development of uranium extraction and purification processes. The volume ends with an adequate but not over elaborate index.

In recent years, many articles have been published in technical journals on the subjects considered in this work but this is the first time that the whole field has been covered in a single book. The book will be invaluable to all who have any connection with winning less common metals from the earth, particularly uranium, whether they be in industry or at university. Also it presents to a much wider group of readers an intriguing account of how a new industry has been built up in a very short time and of the high technical standards achieved in previously unexplored fields. The pleasure derived from its reading is considerably enhanced by the very high editorial standard which has eliminated completely any obvious change in authorship in proceeding from one chapter to the next.

G. K. DICKSON

New Books

Garcke's Manual of Electricity Supply: A Statistical Record of the British Electricity and Allied Manufacturing Industries. Vol. 56: 1958-59 edition. *Electrical Press.* (£4)

The electricity authorities of the British Isles, their stations, service and statistics, are treated in detail, and in addition a quite extensive "who's who" is appended. Surveys of the electricity supply industry in general, and of nuclear power developments preface the volume.

SEIBT: Export Directory of German Industries. 15th edition. *Seibt-Verlag, Munich; M. Neven du Mont, 123 Pall Mall, London, SW1.* (65*s*)

Contains more than 63,000 classified entries, together with indexes to commodities, manufacturers' names and addresses, trade marks and trade names.

Energy Principles in Applied Statics. By T. M. CHARLTON. *Blackie.* (25*s*)

The two basic approaches to the analysis of statistical systems, Castigliano's use of strain energy and the method of potential energy, are considered in detail. Methods involving virtual work and complementary energy are dealt with in the later chapters.

Elements of Modern Mathematics. By KENNETH O. MAY. *Addison-Wesley Publishing Company, Reading, Massachusetts and London.* (57*s*)

Sets out to provide the student with "an orientation in modern mathematics, a basic vocabulary of mathematical terms and a minimum facility in the use of mathematical concepts and symbols."

Descriptive Geometry. 2nd edition. By E. G. PARÉ, R. O. LOVING, and I. L. HILL. *The Macmillan Company, New York and London.* (35*s*)

The layout of this textbook has been designed to give convenient units of work for the organised study course. Problems are given at the end of each chapter.

Modern Electronic Components. By G. W. A. DUMMER. *Pitman.* (55*s*)

A comprehensive survey of the characteristics of the more common components, with consideration of their behaviour under such arduous environmental conditions as found in the tropics, in polar areas and at high altitudes.

Laboratory Instruments: their Design and Application. By A. ELLIOTT and J. HOME DICKSON. 2nd Edition. *Chapman and Hall.* (55*s*)

A fuller account of plastic materials and an additional chapter on radiation have been added to this new edition. The treatment is almost wholly mechanical and optical, with no attempt to cover electronic instruments.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Lighting

Price List. A.E.I. LAMP AND LIGHTING CO. LTD., Melton Road, Leicester. Pocket price list of Mazda lamps, tungsten, sodium and mercury vapour. Booklet.

Adjustable Fittings. JOHN DUGDILL & CO. LTD., Hazel Grove, nr. Stockport. Jointed fittings for bench, table or machine lighting. Portable or fixed mounts. List 9E.

Fluorescent Strip. COURTNEY, POPE (ELECTRICAL) LTD., Amherst Park Works, Tottenham, London, N15. Stripline range of fluorescent batten fittings; one or two light units. Leaflet.

Lighting Fittings. TROUGHTON AND YOUNG (LIGHTING) LTD., 143 Knightsbridge, London, SW1. Ceiling, wall, table, and standard fittings for home or office. Twelve page catalogue.

The Reviewers

Dr. F. T. Barwell is electric traction engineer (research) of the British Transport Commission, and was formerly head of the lubrication division at the Mechanical Engineering Research Laboratory (now the National Engineering Laboratory), East Kilbride. He is a Ph.D., a B.Sc. (Eng.) an a D.I.C. and is an M.I.Mech.E., an A.M.I.E.E., an M.I.Loco.E., an M.I.E.S.S. and a Whitworth Scholar.

Mr. E. R. Wiblin, M.A., is a senior principal scientist in the Industrial Collaboration Office at the Atomic Energy Research Establishment, Harwell. He has been concerned with nuclear physics research and isotope production at AERE, and during the war worked on radar research at the Telecommunications Research Establishment.

Dr. J. M. Lock is a member of the scientific staff in the low temperature laboratory of the Royal Radar Establishment, Great Malvern, which he joined in 1951. He had previously spent four years in Cambridge engaged in research on superconductivity. He is a B.A. in physics and a Ph.D.

Mr. G. K. Dickson, B.Sc., F.R.I.C., M.I.Chem.E., is the technical manager concerned with chemistry and chemical engineering in the Central Technical Services of the United Kingdom Atomic Energy Authority's Development and Engineering Group, at Risley, Lancashire.

Marketing

Another USSR Machine Tool Order

The £200,000 order for 20 Wiedemann turret punch presses for the Soviet Union received recently by DOWDING AND DOLL has been followed by another Russian order, for 20 Dowding universal hobbing machines, worth approximately £47,000. Eight of the machines are for gears up to 8 in diameter and 7 in face width and 12 for gears up to 4 in diameter and 4 in face.

Courtauld Double Expansion

BRITISH CELLOPHANE, which is a subsidiary of COURTAULDS, has bought two more companies, in Scotland and South Africa, further widening its paper fabrication interests.

The Scottish acquisition is the family firm DONALDSON AND FILER, of Pollokshaws, Glasgow, a customer of long standing with British Cellophane, making fine fluted corrugated paper for biscuit packaging and other purposes. The company also has printing and bag-making of cellulose film interests.

In South Africa, PRETORIA PAPER PRODUCTS, of Port Elizabeth and Johannesburg, has been aquired. The company makes bags of film paper and other material.

Starfighter Joint Production

German, Dutch and Belgian authorities have now agreed to the formation of a joint working party towards the building of several hundred LOCKHEED Starfighters. The West German Ministry of Defence has the sanction of its Parliament to buy 630 Starfighters for the Luftwaffe.

Preliminary arrangements are for 96 to be bought from the United States and for some 200 to be built in Europe. Of the three possible alternatives for the rest, one plan would see the fighters being made by a four nation plan involving Germany, Holland, Belgium and Canada. The other alternatives are of heavier orders in the USA or of stepping up output in Germany.

Joint arrangements are also to be negotiated for training and maintenance and there is also to be a degree of standardisation to simplify maintenance at the airfields of the participating countries.

Argentine Trade Prospects

The strain on Argentine-Spanish relations imposed by Spain's unpaid debt to Argentina has been lifted in a way that will not please the shipbuilding industry.

Some 70 per cent of the debt, or £15 million, is to be liquidated by the construction in Spain for the Argentine of oil tankers, small passenger vehicles and cargo ships. The rest of the debt will be repaid in convertible currency.

Speaking in Buenos Aires, President Frondizi has explained how the development of the Argentine oil resources will affect her future market relations with Great Britain. Instead of coal and oil from this country she will be looking for machinery and other equipment. By next year Argentina hopes to almost have eliminated the need to import oil.

Mr. Duncan Sandys, Minister of Aviation, who has been in Buenos Aires, said while there that as Argentina's economic strength grew so would her purchases from the United Kingdom.

Japanese Electronics in USA

The British heavy electrical industry are not alone in having obstacles put in the way of their sales effort in the United States. The Japanese electronics industry has recently been explaining to the United States Office of Civil and Defense Mobilisation that its exports of transistors are not a threat to American security.

The United States Electronic Industries Association had asked the Mobilzation office to investigate the fast growing imports from across the Pacific. From a negligible few, Japanese transistors sold in the United States have risen in two years to a total equal to 25 per cent of United States domestic production.

The Japanese representatives have submitted that they are only competing in cheap transistors for consumer goods, portable radios being the best example. They are not concerned to join in the more costly military market of semi-conductors since these are not made back in Japan.

To the American industry's report that from the profits of "entertainment" level transistors comes the money for research and development of semiconductors, the Japanese have replied with quotations of the multi-million dollar Defense Department contracts for the support of semi-conductor research and manufacture.

Bailey Bridge Firm Merged with Acrow

THOMAS STOREY (ENGINEERS) Limited, makers of the famous Bailey Bridge, have become part of the ACROW GROUP. Acrow take over Storey's, by purchase of the issued stock, at a time when the expanded road programme may reasonably expect to create larger demands for Bailey bridging to alleviate temporary bottlenecks.

Mr. Thomas Storey and his colleague, Major V. B. J. Seely, join the Acrow board.

Foundry for Indian Railways

F. H. LLOYD AND COMPANY, the steel founders, are to act as consultants to the INDIAN RAILWAY BOARD for the design, erection, installation of plant and equipment and personnel training for a steel foundry at Chittaranjan, West Bengal.

The proposed initial output of the foundry is of 7,000 tons of castings a year to be used in the building of 200 locomotives. Operating one of the major rail systems in the world, the Indian Railway Board controls 34,000 route miles and more than 8,000 locomotives.

The foundry is to be put up alongside the assembly bays of the locomotive works and its main buildings will cover melting, coremaking, light and heavy foundry and dressing shops, heat treatment, inspection and despatch. X-ray and other non-destructive testing facilities are to be provided. Molten steel will be provided by two electric arc furnaces.

Personnel training, for a team of Indian technicians who will come to this country, will include foundry and fettling production, production control, estimating, costing and the training of workers in the foundry. F. H. Lloyd will send a site engineer to Chittaranjan who will be followed by a team of technicians responsible for setting up the foundry and bringing it into use.

US Air Force Secondhand Cars

Not everybody in the United States trades in last year's model and buys a brand new car. Least of all the United States Air Force.

The United States General Accounting Office, a kind of administrative watchdog, has detected the USAF in the reprehensible practice of repairing worn vehicles instead of buying new. And this is costing the American taxpayer no small sum.

The GAO report to Congress alleges that in the last three years the USAF has spent $5 million more on repair costs and in depreciated market values than it would have cost in repair charges and depreciation value for new replacement vehicles.

On top of this the Air Force has waited for its new vehicles and watched the total estimated price of the replacements rise by $3 million and for several years to come, reports the GAO, about $2 million will be spent unnecessarily on maintenance because of the inadequate long range replacement programme.

What this adds up to is a Service example of the "public poverty and private wealth" that so many American figures increasingly criticise.

Back to the Foundation

A £750,000 print works in historic Bunhill Row is to be built for THOMAS DE LA RUE and company on the site where the company's founder, Thomas de la Rue, first started his printing business in 1834.

Four of the five factories there, to which the firm had grown by 1940, were destroyed by air raids in the Second World War.

The new works on the old site will be of great day-to-day convenience since much of the company's work is with City financial houses. From printing stamps and banknotes, and making note printing and counting machines, Thomas de la Rue and company are now printing throughout the whole range of financial documents from bonds to luncheon vouchers including cheques, dividend vouchers and security documents.

Structural and Stainless Merger

METAL PROPELLERS LIMITED, the stainless steel design and fabrication company, have broadened their interests into structural steelwork by the purchase of the STANDARD STEEL (1929) LTD.

Standard Steel are constructional and mechanical engineers particularly concerned with the supply and erection of structural steelwork. One of their recent large contracts was the steelwork for the new £1 million Croydon Technical College, in Surrey.

Richardsons Westgarth Sales Move in USA

RICHARDSONS WESTGARTH INCORPORATED has been set up, with offices in Washington, D.C., as a subsidiary company acting as a selling agent in the United States for Richardsons Westgarth, of Wallsend, Northumberland. In addition to acting as agent for products made by the parent company in Britain the new subsidiary will act as main contractor where plant is made in the States to Richardsons Westgarth designs.

The company's products range over land and marine equipment, steam and gas-turbines, complete power station plants, sea water and industrial evaporators, and marine diesels and steam turbines.

Five Second Cup of Tea

Seven choices of the way you like your coffee are offered by the automatic vending Hotspa machine being shown at the Vending Exhibition, Olympia, 15 to 18 February, by the BRITISH AUTOMATIC COMPANY. Another machine pointedly illustrates the forward movement of automatic selling in that it dispenses articles now priced up to six shillings.

BAC are also showing a machine that serves a hot, sweet cup of tea five seconds after the money has been pushed in. If the machine is not up to the right temperature it will not accept coins. A push button prevents sugar being added for those who do not take it.

Two questions about vending machine convenience stand out clearly. Why does the Colespa machine, offering a choice of seven cold drinks, present the drink to its patron only a few inches above the ground? This is unnecessary back-bending and possibly dust collecting. On another machine, as on so many, a "sold out" light appears when the machine is empty. It would perhaps be better if the light were on when the machine was full and out when empty. That way if there was any electrical fault, which might put the whole machine out of operation, the customer would not put his money in under the false impression that he was going to get something for it.

Budd Company Merges Divisions

Greater sales, management and operating efficiency are the targets of the BUDD COMPANY, of Philadelphia, Pennsylvania, USA, in merging its Tatnall measuring systems division with the nuclear systems division.

The five product departments of the new division will be: Metalfilm strain gauges and transducers (marketed under the Tatnall mark), universal, fatigue and creep rupture testing machines (under Tatnall and Tatnall-Krouse marks), PhotoStress, Non-Destructive Testing and Nucleonics.

Coin-operated Mechanisms

All vending machines have this much in common: they must have a coin selector for testing whether the coin is satisfactory or not. At least eight such tests are recognised.

Few people using a cigarette machine or a pay telephone box give a thought to what goes on inside, but any vending machine of this kind must, of course, have some mechanism for testing the coin that is offered to it. This selector, as it is called, must reject the coin if it does not come up to standard, and accept it if it is all right. After this, the coin has to operate another unit—the release mechanism—to free the goods to be sold (or extend the line, in the case of a telephone) either mechanically, by using the coin as a missing link or trigger, or electrically with micro-switches, relays and solenoids.

The coin selector varies according to the type of machine, its application, and where it is used. For example, on machines that are fully automatic and call for very rapid operation, like the ticket-issuing and change-giving machines used on the London underground railway stations (made by Brecknell, Dolman and Rogers Limited, Pennywell Road, Bristol 5), speed is essential during peak periods. The coin selector thus has to be very quick and self-clearing so that, if a coin is not accepted, it must be automatically rejected without delay. On vending machines for goods like cigarettes and confectionery, speed of operation is not so essential and coins that are not accepted are sometimes held in the coin selector until the operation of pressing a button, or pulling a drawer, releases them.

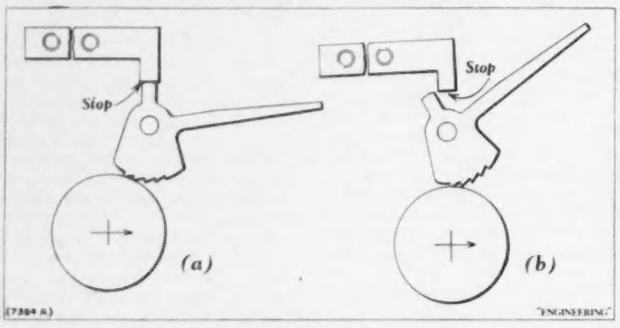


Fig. 1 Milled edge test. The coin moves in from the left. If it is (a) *unmilled, it merely lifts the chopper against the stop and is arrested. If it is milled, as in* (b)*, then the coin rotates the chopper and lifts it clear of the stop, so that the coin is accepted.*

COIN SELECTORS

Coin selectors all seem to work very much on the same principle and have to carry out many of the same tests, of which there are about eight in all. In many machines, the selector has to carry out only some of these tests, depending on the kind of vending machine, the type of coin and other factors. There are in fact many makes of selector, but most of them are easily adjusted for different coins.

Washer test. This is to check whether a washer with an internal hole and not a coin is being used. One method uses a spring-loaded feeler to engage with the hole, if there is one. Another uses a swinging pawl.

Maximum thickness test. The coin passes through an adjustable set of rails if it is not too thick.

Minimum thickness test. The coin falls through a gap if it is too thin.

Weight test. Detects coins that are too heavy or too light by means of a pivoted weighbridge.

Maximum diameter test. An adjustable rail prevents the coin that is too large in diameter from passing through.

Minimum diameter test. The coin falls into the reject bin if it too small in diameter.

Milled edge test. If the coin is milled it rotates a chopper-like cam (Fig. 1), so that it clears a stop and the coin is accepted. An unmilled coin merely lifts the chopper against the stop and is arrested. An alternative to this test is the rim test carried out by a pair of pivoted claws acting caliper-fashion to find the thickness just under the rim.

Magnet test. Checks the material content (steel, nickel or non-ferrous), a magnetic material being arrested.

Another test sometimes used depends on the speed with which the coin approaches a gap. This speed depends on the electrical properties of the coin which in turn depend on the composition of the coin. If the composition is not just right, the coin approaches too fast or too slow, does not bridge the gap correctly and is rejected. There is also the bounce test, wherein the coin falls on to a hardened steel block. If it has the correct hardness, it bounces off the block through an opening in the selector and is accepted.

The information on these tests has been provided by four makers of coin selectors: Aldebert Engineering Company Limited, 2a Aldebert Terrace, South Lambeth, SW18; Associated Automation Limited, 70 Dudden Hill Lane, Willesden, London, NW10; BAC (Machine Sales) Limited, 14 Appold Street, London, EC2; and Brecknell, Dolman and Rogers Limited, Pennywell Road, Bristol 5.

Three typical machines made by Associated Automation Limited, 70 Dudden Hill Lane, London, NW10, are described in the following paragraphs.

Stamp Vending Machines.—In their stamp vending machine, the energy required to operate the machine is derived from a driving weight which is raised when the coin is inserted, as will be understood from Fig. 2. The force is then applied through a driving bar, pinion, pawls and gear wheel to the main spindle that carries the stamp feed-wheel. The coin tester is a compromise between the desire for a stable and trouble-free arrangement that will pass at the first attempt any coin of correct value, and the need for rejecting coins of incorrect value, discs and the like. After the coin has been accepted, it triggers off the release mechanism and drives out the stamp. The same type of machine is used as standard equipment by British Railways for delivering preprinted platform tickets.

Card Vending Machine.—The card vending machine can be used for letter cards, postcards, envelopes and the serrated multi-tickets used in canteens. It has also been tried out experimentally for postal orders. An ordinary coin release mechanism is employed and the machine can be arranged to take one, two or three coins, separately or in combination.

One interesting feature is the way in which the cards are arranged on a cruciform stack so that alternate cards—they must be rectangular in shape—have their long sides the same way. This method does away with the need for anything elaborate in the way of a separating device. The same type of machine is used for selling insurance policies at London Airport. It is a very simple machine compared with its United States counterpart.

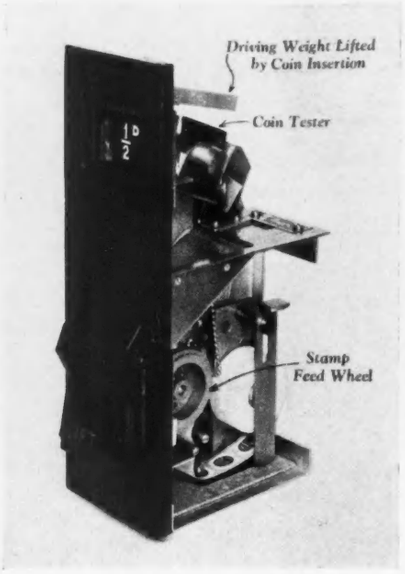


Fig. 2 Shows how the stamp vending machine works.

Coin Collecting Telephones.—Two main types of coin collecting telephone are made by this company. The first type is suitable for automatic local calls and long-distance operator-assisted calls. It has a normal coin box rejecting mechanism, so arranged that when the coin has been accepted, it gives a bell note to the operator, if a trunk call is being made. The coin then operates a balance arm, opens a set of contacts and extends the line to the phone. There are three models: with A and B buttons, with B button only and with no buttons at all. The other type is quite different. It is a pay-on-answer phone (see Fig. 3) for direct dialling without an operator. It is to be used throughout the country by the GPO and at present is being tried out in the Bristol area. The coin selector is once again similar to the ones already discussed. When the coin has been accepted it actuates a cam bank and thus registers the appropriate coin impulses.

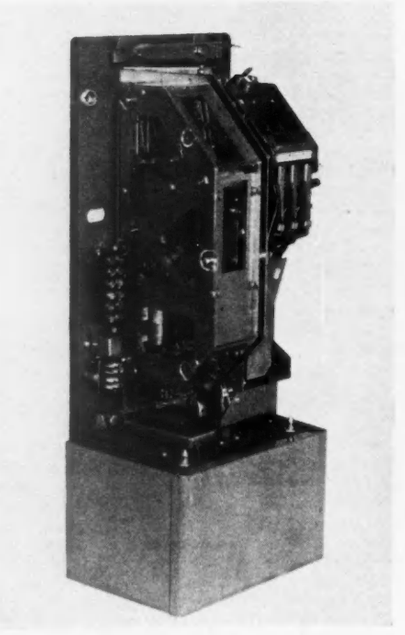
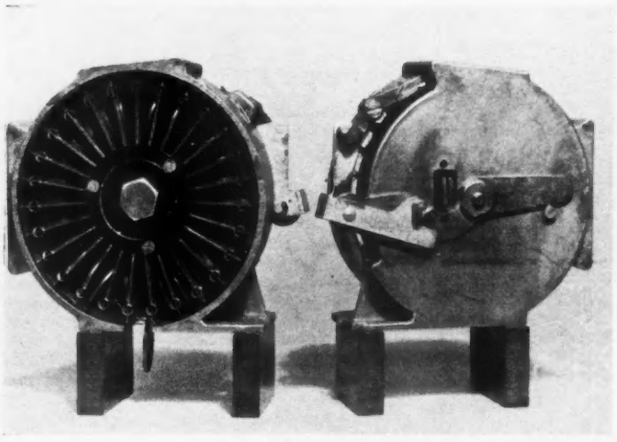


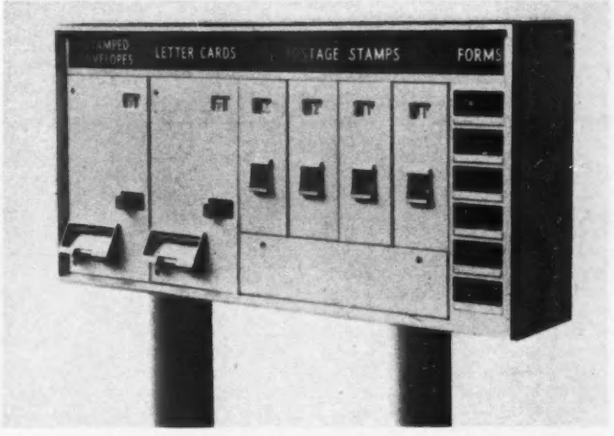
Fig. 3 Mechanism of the pay-on-answer telephone.

(Left) Behind-the-scenes view of the Sankey Vendo machine for selling refrigerated milk.

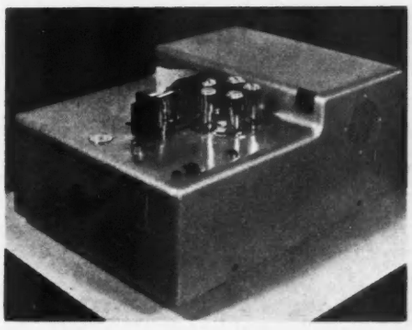
(Above) The Sautocount (ICC Machine Co.) can count up to 5,000 lb of mixed coins in an hour.



Change-giver made by Bracknell, Dolman and Rogers is in the form of a rotating paddle wheel. As this turns, the coins fall down into the change cup.



Suite of postal vending machines developed by Associated Automation Limited, now installed at the Remnant Street, London, post office.



(Above) De La Rue banknote counting machine checks used notes at the rate of 15 a second.

(Left) Vibro-massage machine (British Automatic Company Limited) for toning up tired feet.

(Right) The system of endless motor-driven belts is shown in this rear view of the Electroshop 24.

High Temperature Strain Gauging Simplified

The HTM Mono-Filament strain gauge and strain insert represents a new type of strain transducer developed by the High Temperature Instruments Corporation, Bala-Cynwyd, Pa., USA. The construction of this transducer opens new areas to strain measurement, at both room and elevated temperatures, and permits a great simplification in the installation of high temperature strain gauges.

The gauge is made in four standard configurations and in four standard series. The series designation is determined by the wire from which the strain sensitive filament is made. The designations are:

HTM-100 Karma (stabilised).
HTM-200 Nichrome V (stabilised)
HTM-600 Special HT 600 alloy
HTM-1200 Special platinum base alloy.

Gauges are available in 60, 120, and 240 ohms resistances.

Configuration A (as in Fig. 1) is the basic unit. It consists of a single strain-sensitive filament, attached to suitable heads and coated with an electrically insulating cement. The cement is cured and the entire unit thermally cycled for maximum stability of the strain sensing element, and maximum stability and resistance of the insulating cement. The coating of electrically insulating cements permits the direct application of the gauge, without prior precoating of the test member. It also permits the use of cements that do not have the insulating value of the best ceramic gauge cements, but which cure at a lower temperature. The particular design of this sensing element eliminates transverse sensitivity.

Configuration B is an adaptation of A to which a thermocouple has been added. This thermocouple is completely insulated and is extremely small, so that it can sense very rapid changes in the temperature at the centre of the strain element.

In configurations C and D (as in Fig. 2) an aluminium oxide insulating guide is used to support a portion of the lead wires. This guide makes the whole unit more rigid and facilitates the use of the gauge as an insert. As in the other configurations, the active filament is coated with electrically insulating cement and cured. Configuration D is manufactured with a highly responsive thermocouple to sense rapid changes in the temperature at the centre of the strain element.

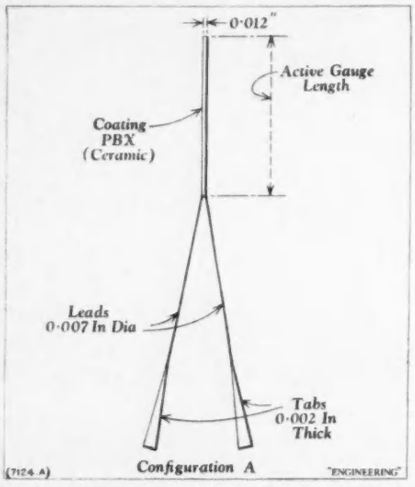


Fig. 1 Configuration A, the basic unit. It has a single strain-sensitive filament.

An important area of use for the Mono-Filament strain gauge is on specimens that will be subjected to high temperatures but cannot be subjected to an initial high temperature cure. Strain measurements on aluminium alloys fit into this category. A second important area of application comes from the ease in which configurations C and D can be installed in extremely small holes. This feature makes them ideal for insertion into the centre line of bolts, studs, rivets, turnbuckles and other structural fasteners, where the insert would respond to axial loads only and be insensitive to torque and bending. One very interesting application of this idea is the use of such an insert in explosive bolts, to separate the stages of a missile. Other areas of application of the gauge would be in very narrow sections such as ligaments in tube sheets and headers; on small tubes, rods, spokes and wires; in crevices, corrugations, keyways and gear teeth. An important special application of this type is in honeycomb and corrugated structures, designed for high temperature structural applications. The ease with which these gauges can be installed on the narrow portions of these structures (and the high operating temperature of the gauges) make them ideal for thermal and other structural tests. One other area of application would be in castings, where the gauge could be cast directly into plastics or low melting metals.

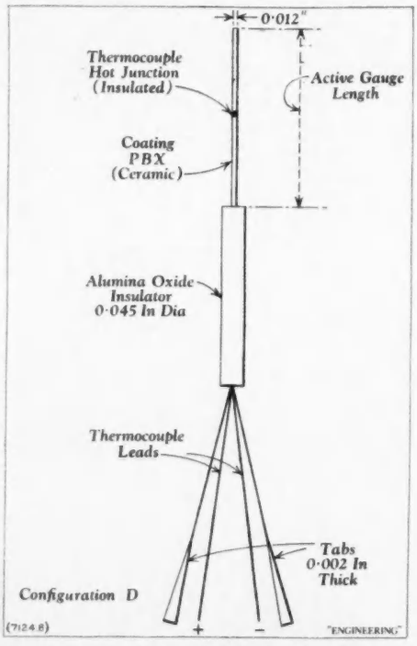
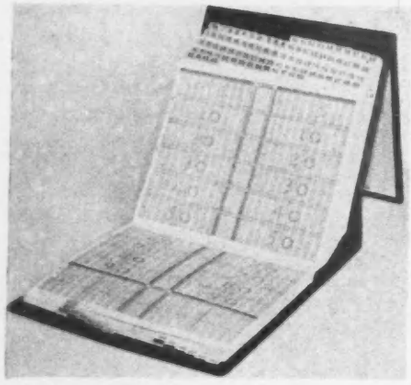


Fig. 2 Configurations C and D have an aluminium oxide insulating guide to support the lead wires.

The gauges are coated with a ceramic insulating cement to provide an extreme range of operating temperature. (Other cements can be provided upon special request.) The useful temperature range of the gauge will then be determined by the cement used to attach the gauge to the test member. Recommended temperature ranges are:

Bakelite	− 100 to + 350°F
Epoxy	− 100 to + 500°F
Ceramic	− 325 to + 1,200° F (static)
	− 325 to + 2,000°F (dynamic).

Cheap and Easy-to-Use Desk Calculator



The Bergmann Unical decimal desk calculator is in card index form and weighs only 7 lb. It can be operated easily with one hand.

The Bergmann Unical decimal desk calculator, manufactured in Switzerland and handled in this country by Kenneth Miles, 13 Netherall Gardens, London, NW3, gives quick and accurate results. It is based on a system that has been in use on the Continent for a number of years. In some ways it is similar to the slide rule, mainly because it is non-mechanical, but differs substantially from it otherwise. The calculator is made in card index form and consists of 99 pre-calculated tables ranging from 1 to 9,999. As the decimal point can be shifted at will in any direction the range includes digits such as 0·0001 and 9,999,000. Zeros can also be added as desired. Each of the 99 tables has an indicator tab denoting the prefix number of the respective table, that is, from 1 to 99.

The calculator can be used for an almost unlimited variety of calculations. A few examples of the types of calculation that can be read at a glance directly from the tables are:

96·45 × 45	=	4,340·25
14·45 × $\frac{1}{16}$	=	0·9031
41 per cent of 1,295	=	530·95
Yearly Total	=	8,445
Monthly figure	=	703·75
Weekly figure	=	162·4

Any figure from 1 to 9,999 can be multiplied immediately by $\frac{1}{12}$ to $\frac{11}{12}$, $\frac{1}{8}$ to $\frac{7}{8}$, $\frac{1}{6}$ to $\frac{5}{6}$ or by $\frac{1}{10}$, $\frac{1}{32}$, $\frac{1}{128}$ and $\frac{1}{64}$. Conversion from British to metric weights and measures and vice versa can also be carried out very quickly.

For statistical purposes any "base" can be sub-divided into percentages quickly and accurately. Calculations such as 12,345·75 × 6·735 can be carried out quickly with the aid of a few additions of precalculated results. Division also can be carried out quite easily. In multiplication, there is no limit to the size of the multiplicand. In division, the dividend is unlimited but the divisor cannot exceed four digits. The system can be learnt in a very short time.

The unit weighs 7 lb, works noiselessly and requires no repair. It is easy to carry from place to place and is operated with one hand while the other hand writes down the results.

The Technical Problems of Broadcasting

Part 4—Feeding the Transmitting Aerial

By F. D. Bolt, B.Sc. (Eng.), M.I.E.E.
British Broadcasting Corporation

Losses occur when feeding the output of a radio frequency transmitter to an aerial, especially when the path length is great. The frequency of the transmitter has a considerable bearing on these losses.

Frequencies of the order of 100 Mc/s are used for television and sound broadcasting and powers up to 50 kW have to be taken as efficiently as possible over distances, between transmitters and aerials, of 500 to 1,000 ft. Losses due to both insulators and radiation (see Table I) can be reduced to a small percentage of the total by proper design. Dielectric losses can be reduced by employing air insulation as far as possible and using, for solid insulation, materials such as polythene and ptfe which have power factors of less than 0·0005. Radiation losses are practically eliminated by employing transmission lines of coaxial form where one conductor completely screens the other and the electromagnetic field is confined to the interspace between them.

The well-known principles used at power frequencies for the prevention of corona apply equally to high-frequency lines, and, provided due attention is given to the radius of curvature of the conductors, excessive voltage gradients can be avoided. The loss due to the resistance of the conductors remains as the major cause of inefficiency, and, though it can be reduced by ensuring that the current flows evenly over the conducting surfaces, the resultant heating limits the maximum power that can be conveyed at very high frequencies to a small fraction of that which can be transmitted at 50 c/s over conductors of comparable size.

Table II shows the limitation imposed by temperature as compared with that imposed by voltage on typical coaxial feeders. Rigid feeders are limited to a maximum temperature of 100° C to prevent ageing of the inner copper conductors, and cable feeders to 80° C to prevent softening of the polythene insulant.

Two main types of coaxial transmission lines having characteristic impedances of either 70 or 50 ohms are in use by the BBC: (*a*) rigid lines built up from 12 ft lengths of copper tube; (*b*) semi-flexible cables in continuous lengths up to 600 ft. In addition an intermediate type with a built-up rigid outer conductor and a continuous semi-flexible inner conductor has been in use for a number of years.

TABLE I.—*Transmission Line Losses*

Cause	Effect in relation to frequency	Magnitude at 10^8 c/s Magnitude at 50 c/s
Resistivity of conductors	Resistance of similar conductors varies as square root of frequency	1,400
Power factor of insulators	Dielectric losses proportional to frequency	2×10^6
Incomplete confinement of the electromagnetic field to the transmission route	(i) Radiation loss: proportion to frequency	2×10^6
	(ii) Induction loss: constant	1
Disruptive discharge	Breakdown stress practically constant	1

TABLE II.—*Temperature and Voltage Limitations*

Outside diameter of coaxial transmission line	Efficiency for 500 ft	Thermal rating max. power at 100 Mc/s	Voltage rating max. power
2 in rigid	80 per cent	20 kW	200 kW
3½ in rigid	85 per cent	45 kW	500 kW
5 in rigid	91 per cent	105 kW	1,000 kW
1⅛ in cable	70 per cent	6 kW	200 kW
3⅛ in cable	85 per cent	20 kW	500 kW

RIGID TRANSMISSION LINES

High conductivity copper is used for both conductors and in the case of lines installed recently the inner conductor is loaded with 0·1 per cent silver to improve its mechanical characteristics. The outer tubes are jointed by brass flanges sometimes brazed but preferably hard soldered to the tubes, the bolted joints being air-sealed by means of a synthetic rubber ring.

Straight vertical lengths up to 750 ft are commonly used on masts, and close tolerances on straightness and diameter are necessary for the individual 12 ft lengths to ensure that the full length fits accurately within the mast. In some designs shallow flanges are used for jointing, the mating surfaces being machined normal to the axis of the tube in a lathe after brazing or soldering. The flanges have sufficient depth to ensure that their faces are maintained closely normal to the axis of the tube. Feeders that are fixed to a mast (as illustrated in Fig. 1) are anchored to the steelwork at points spaced some 150 ft throughout their length and between these anchor points an expansion joint is fitted to allow differential expansion to take place between mast and tubes. At intervals between the anchor points there are guides which allow vertical movement only. The inner conductors are locked to the outer at the anchor points by means of a disc-shaped insulator, and throughout their length are held concentric with the outer by means of ptfe peg insulators spaced 1 ft apart axially and 120° radially. Electrical contact between 12 ft inner conductors is made either by a bullet-shaped spring insert or by a diabolo-shaped insert, which is engaged by a set screw so as to force the inner conductor tube ends together to form a peripheral contact.

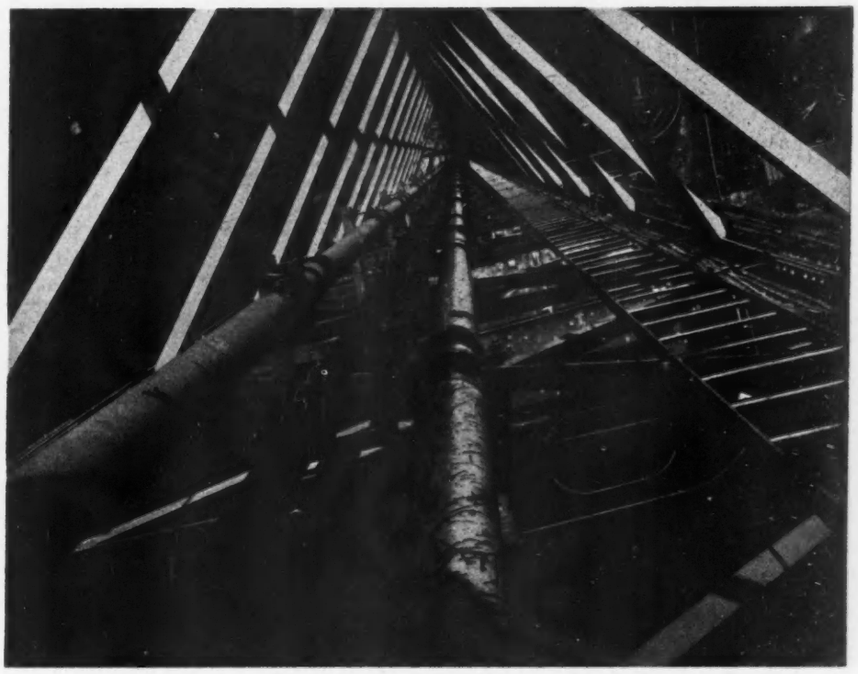
The expansion joints are designed to allow 1 in differential expansion between the outer copper tubes and the supporting structure and 2½ in differential expansion between inner and outer conductors over each 150 ft length, these figures being based on a maximum inner conductor temperature of 100° C.

SEMI-FLEXIBLE CABLES

The largest r.f. cable in use by the BBC is 3⅛ in diameter over the outer aluminium conductor, and the copper inner conductor is held concentrically by a helical insulating membrane of polythene. In long lengths the assembly forms a composite entity and no differential expansion occurs between conductors. Polythene insulation puts a limit of 80° C on the temperature of the inner conductor. When mounted vertically these cables are anchored at the top and held throughout their length by clamps which permit axial elongation relative to the supporting structure. The aluminium outer is protected by a pvc paint applied after installation.

Both rigid and semi-flexible transmission lines are kept dry and clean internally by means of filtered and dehydrated air at a pressure of some 12 in water gauge.

The intermediate type of line is interesting in that while the outer conductor is a built-up rigid tube, the inner is a continuous rope having a steel wire core and locked copper strands lapped over the core. This rope is anchored at the top



Television and VHF radio aerial feeders may be anything up to 1,000 ft long. The illustration shows feeders on the Kirk O'Shotts BBC transmitting mast, looking down from a 570 ft high maintenance platform.

Continued on next page

of the vertical run, and expansion is taken up at the bottom by means of a counterweight mechanism. Ptfe pegs hold the inner concentric to the outer tube. This form is not used for horizontal runs.

The electrical length of transmission lines used between generator and load at radio frequencies usually corresponds to many times the wavelength of transmission (which in free space would be 3 metres at 10^8 c/s) and the solution of the transmission line equations is simplified by employing the concept of two waves, one travelling forward between generator and load and the other a reflected wave travelling in the reverse direction. This is inherent in the solution of the general transmission line equations relating the current and voltage along the line to the values at the sending end. The magnitude of the reflected wave depends on the disparity between the load impedance and the characteristic impedance of the line, and since forward and reflected waves will at some points be in phase, higher voltages and currents than should be necessary for transmitting the required amount of power are set up.

A far more important effect is that the reverse wave can be reflected again by the transmitter to travel forward with the primary wave carrying identical programme information, but with a time delay equal to twice the length of the transmission line divided by the velocity of propagation. For line lengths of 1,000 ft the delay is about 2 micro-seconds, which is comparable with the elements of information in a television picture, so the combined primary and reflected waves could produce a distorted picture. For television purposes the reflected wave must not exceed 1 per cent of the primary wave at the vision carrier frequency. Transforming and phase-correcting networks are therefore inserted between the aerial and the transmission line, and these must be accurately adjusted, after installation on the mast, by comparison with a known impedance. These networks are themselves built up from coaxial line sections.

The most accurate standard of impedance for all types of transmission line measurements is a length of actual line, since the physical conformation can be made to approximate very closely to the theoretical form from which the characteristic impedance is derived. Small errors introduced by the connections between the lines and the test equipment can be eliminated by averaging readings taken with and without the insertion, of a standard quarter wavelength of line of known characteristic impedance. By this technique, field measurements are reliable within $\pm$ 1 per cent. The labour involved in the solution of all line problems of the kind described above is much reduced by the use of a Smith chart.

When a transmitting installation is in service the reflection factor is continuously monitored by an instrument that indicates the power ratio of the forward and backward waves and is arranged to trip power from the transmitters if a fault develops in the aerial system.

Testing the Red Shift Theorem

A negative postulate of the form " there is no way of detecting a certain phenomenon " sets an impossible task to the experimental physicist. As there are an infinite number of ways in which one might attempt to detect the phenomenon, proof of the postulate will be incomplete as long as any of an infinity of methods has been left untried. A fundamental tenet of Einstein's general theory of relativity is the principle of equivalence, which is stated in the negative form: There is no way of detecting any difference between the effects of uniform acceleration and a uniform gravitational field.

According to this principle, occupants of a rocket accelerating uniformly would have the same sensations as persons standing on earth. there would be no feeling of weightlessness; it would require a measurable effort to rise from the " ground "; liquids could be poured from one glass into another; and should one of the glasses slip from the hand, it would " fall," and most likely shatter.

Proof of the principle of equivalence can only come from overwhelming statistical evidence. Having performed a large number of independent tests inside a rocket and on earth with identical results, one might declare that Einstein was probably right after all. As the theory of relativity has proved eminently successful both in cosmic and atomic research, such a declaration would of course require a tongue placed firmly in the cheek. Four scientists at Harwell have recently performed an elegant demonstration of the principle of equivalence in two experiments making use of a property of the radioactive isotope, iron 57.

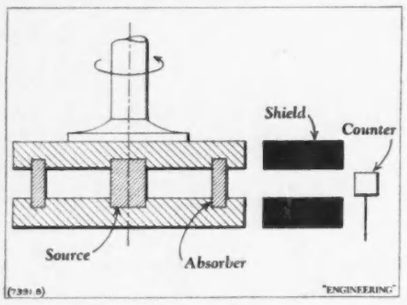
ACCURACY

One of the predictions of the General Theory is that a gravitational field has an effect on electro-magnetic radiation. For instance, Einstein anticipated that the wavelength of light emanating from a star would increase under the influence of the star's gravitational field, and white light would tend towards red. The phenomenon, dubbed " red shift," has, until now, remained unconfirmed. Astronomers have actually observed the red shift, but so many other influences operate besides gravity that a quantitative measurement has been impossible.

The general validity of Einstein's theory could be put to a test if a suitable controlled laboratory experiment were devised in which the change in wavelength of some radiation under the influence of gravitational fields and acceleration is measured. The reason that such an experiment has so long remained unperformed was the need for unprecedented accuracy. The predicted red shift in the earth's gravitational field is only one part in 10^{15} over a distance of 25 ft.

A German physicist working at Munich, Dr. R. L. Mossbauer, discovered recently that a radioactive isotope of indium emits gamma rays of a very definite energy, with a spread of only one part in 10^{11}. The discovery was surprising because, due to the thermal motion of the radioactive nuclei, one would have expected the emitted gammas to show a considerable spread of " smear " of energies. However, more and more phenomena on the subatomic scale are found to show this characteristic of occurring at discrete and unique energies, that is, of being " quantised."

When Dr. Mossbauer directed the radiation at a target of the same material as the emitter, he found that the gamma rays were largely absorbed. But when the radioactive source was set in slow motion, at a speed not greater than a fraction of an inch per second, the absorber became practically transparent to the radiation. Dr. Mossbauer attributed the change in resonance absorption to a very small Doppler shift in the energy of the emitted radiation caused by relative movement between source and absorber. By plotting absorption at various relative velocities it was possible to determine the energy spectrum of the gamma radiation.



Designed for 30,000 r.p.m. the rotor experiment produced accelerations of 65,000g.

At Harwell it was discovered that iron 57 emits a similar well defined gamma radiation, but with a " smear " a hundred times smaller than that of iridium! And it was recognised that the accuracy and sensitivity of the iron 57 resonance absorption was just within the range required for the detection of the red shift.

The idea of using iron 57 to put Einstein's theory to test occurred to a number of people on both sides of the Atlantic roughly at the same time. At Harwell, Dr. T. E. Cranshaw, Dr. J. P. Shiffer and Dr. A. B. Whitehead devised a test that is now known as the " water tower experiment." In one of the Harwell water towers an iron 57 source was installed at a height of 40 ft above the ground. An evacuated tube ran down to ground level, and at the bottom an iron 57 absorber was placed above suitable counting equipment. The emitter was given a sinusoidal motion with an amplitude of 0·7 microns at 50 cycles per second, and the transmitted radiation measured and recorded with two sets of decatron counters at various emitter velocities.

Because of the random nature of the radioactive decay process, the experiment had to be designed for very high statistical accuracy. After a three weeks experimental run, the red shift predicted by Einstein was demonstrated with a probability of $0{\cdot}95 \pm 0{\cdot}43$. Stated more simply, the chances that Einstein was wrong are one in sixty.

Harwell's water tower experiment is the first reported verification of the existence of a red shift. At Harvard University Professor Roscoe Pound and Mr. Rebka are working on a similar experiment, but using a much more powerful emitter. Although late starters, the availability of the stronger source has enabled the Harvard team to cut the experimental time, and it is expected that publication of results will follow quickly. Similar work is in progress at Manchester University, but using zinc 67 instead of iron 57.

ACCELERATION

Having completed the first half of the experiment—the measurement of the red shift in a gravitational field—a second experiment had to be devised to test the theory under conditions of acceleration. Not having a suitable space rocket available to attain sustained linear acceleration, the Harwell team had to resort to radial acceleration. Dr. H. J. Hay, another Harwell scientist, was called in as consultant in the design of a high speed rotor of extreme stability. Dr. Hay had been working on fast neutron-choppers using multiple synchronised rotors. The rotor illustrated was designed and fabricated out of Dural. To attain comparable accuracy to that of the water tower experiment, accelerations of 65,000g. were required. The rotor had to be designed for a speed of 30,000 r.p.m. and Dr. Hay chose a combination magnetic and air bearing to eliminate rotor vibrations. Smooth running of the rotor was essential because vibrations would superimpose random accelerations on the experiment which would seriously affect its accuracy. The rotor weight is carried by magnetic forces between a coil and the rotor shaft. Lateral support is provided by a suitable air bearing of very low friction.

The iron 57 emitter is placed at the centre of the rotor, and the absorber located on the rotor periphery. A gamma-ray counter, shielded against scattered radiation, is placed near the rotor and the transmitted radiation measured at different rotational speeds. A plot of transmitted radiation against speed indicated that the effect of acceleration is similar to that of the gravitational field within the accuracy of the experiment.

Nations Get Together on Space Research

Space research is rapidly becoming more international. Nations from both sides of the Iron Curtain recently met in Nice to exchange information and pave the way for still further cooperation.

When the Russians threatened to withdraw from the International Committee on Space Research (COSPAR) some months ago, it seemed that to continue this body would be like performing Hamlet without the Dane. However, negotiations have taken place behind and between the scenes, the constitution has been revised, and when the third full meeting of COSPAR was held at Nice from 11 to 16 January, both Russian and American vice-presidents were appointed. They will no doubt dominate the governing body, which will have a neutral President (the Dutch radio astronomer, Professor H. G. van de Hulst) and representatives from Czechoslovakia, France, Poland and the United Kingdom (Professor H. S. W. Massey, of University College, London). Membership of COSPAR itself will be open to the academies of science of all countries, whether or not they have active space science programmes.

A wider participation in this field and increased cooperation between nations are to be encouraged. Twelve nations have expressed interest in the United States offer to put instruments from other countries in satellites to be launched by their Scout rockets. It was agreed that all nations should work together to avoid unnecessary duplication of research work. As yet, Russia has neither offered space in its rockets nor given advance details of the work it proposes to do. Another recommendation was that the radio frequencies used in space research should be standardised as much as possible and that satellites should contain some provision for switching off their transmitters when they had reached the end of their useful life, so that the available frequencies would not become cluttered up. Standards for sterilising space vehicles so as to keep space and other planets free from terrestrial bacteria are to be evolved.

Associated with the meetings of the committee was the First International Space Science Symposium, at which over 100 papers were presented on the earth's atmosphere, the ionosphere, solar and cosmic radiation, interplanetary dust, the Moon and planets, tracking and telemetry, and meteorites.

A number of the contributions concerned the Van Allen radiation belts, which were the first major discovery to result from satellite research, and which are receiving considerable attention, partly because little is known about them, partly because they offer us a chance of learning more about cosmic and solar radiation, and partly because they may present a serious hazard to man in space. In their paper " Observations of Van Allen Radiation Belts during Geomagnetic Storms," R. Arnoldy, R. Hoffman and J. R. Winckler reported a radiation detection experiment made by the University of Minnesota in the Explorer VI satellite, launched on 7 August, 1959, from Cape Canaveral. The package placed in the payload consisted of an integrating ionisation chamber operating on the pulsing electrometer principle and a Geiger counter. Both instruments are sensitive to all types of radiation, but by taking the ratio of their counting rates it is possible to obtain a measure of the mean particle ionisation and hence the particle energies, if the type of particle is known.

Successful telemetry from the package saw maintained until 6 October, the satellite travelling in a high-ellipticity orbit with apogee 48,000 km from the earth's centre. Measurements during the first two weeks indicated that the high intensity radiation regions had shrunk considerably and changed form since Van Allen's observations in the spring of 1959. Then on 16 to 17 August a strong magnetic storm occurred. During the first 24 hours this was accompanied by a large loss of radiation from the outer Van Allen region. On computing the latitudes on the Earth's surface at which the radiation would be precipitated if it had been dumped down the lines of magnetic force, these agreed with the location of a very strong aurora observed on the night of 16 to 17 August. This was of the type which occurs at balloon altitudes and produces strong X-ray bursts. The exact mechanism of dumping is not clear, but it appears to be connected with heating and expansion of the upper layers of the atmosphere. After the storm ended on 18 August there was a very large increase in the radiation intensity to a value much higher than that characteristic of pre-storm conditions.

Another period when substantial increases were observed began on 22 August and lasted for 5 to 6 days. This activity was associated with the occurrence of a long-lasting solar radio noise storm but with no definite geomagnetic effects. Data obtained during geomagnetic disturbances on 4 and 23 September are still being interpreted.

SOFT RADIATION EXPERIMENTS

Two other radiation experiments were aboard Explorer VI: A. Rosen, T. A. Farley and C. P. Sonett (National Aeronautics and Space Administration) gave the results they had obtained in measuring the soft electron flux with scintillation detectors. These results were in general agreement with the University of Minnesota observations: there were large time variations in the outer Van Allen zone but the inner zone was relatively stable. In addition to the day-to-day changes in intensity, short-term fluctuations over periods of less than a second up to a few minutes were observed at radial distances of 35,000 to 48,000 km. In one fluctuation the intensity rose to about 5,000 times the normal base value.

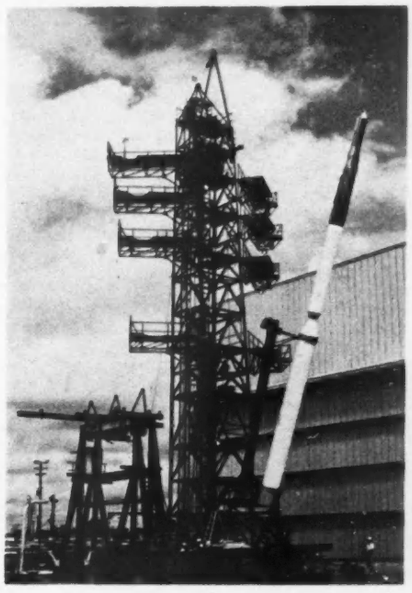
Measurements made using a magnetic spectrometer carried by a rocket have given the electron energy spectra as a function of altitude, and thus present an " instantaneous " vertical section of the radiation field. The question of the ultimate origin of the radiation is still unsolved, some scientists favouring the sun, others cosmic rays. Much more research is needed, for the behaviour of the belts seems to be about as irregular and unpredictable as British weather.

Two of the Russian contributions were concerned with radiation measurements obtained during the flight of Lunik II. These included both observations when passing through the Van Allen zones and a search for similar belts in the vicinity of the moon. During the descent to within 1,000 km of the lunar surface an increase in intensity exceeding 10 per cent of the background cosmic radiation was not detected. It was difficult to obtain accurate data over the last 1,000 km before impact, due to the short time of flight over this part of the trajectory but no considerable increase in intensity was apparent. It thus seems unlikely that lunar radiation belts exist.

After Lunik II had reached a point 70,000 km from the earth's centre, all instruments recorded a constant cosmic ray intensity, although values inside and outside the vehicle differed, as a result of secondary radiation being produced on passage of the charged particles through the shell.

LIFE ON MARS?

Although the majority of the papers were concerned with space physics, a few touched upon biological problems. R. W. Davies and M. Gumpel of California Institute of Technology outlined a proposed experiment for detecting the presence of life on Mars. This would involve sending a stabilised space probe to within



Several nations have expressed interest in the US offer to launch satellites with the Scout rocket. The illustration shows a structural test Scout, mounted on its 109 ft launcher in a 20° tilt position, ready for firing.

10^6 km of the planet, to scan its surface for reflected radiation in the 3 to 7 micron region with a 500 Angstrom bandpass. The spectra would be correlated with the visual light and dark areas. An accompanying experiment would be to measure the light polarisation of Mars as a function of the probe-Mars-Sun angle: this would give additional information on the sizes of particles in the Martian atmosphere.

Professor A. Blagonravov, head of the Russian delegation and author of a paper on the photographs of the reverse side of the moon, confirmed that the USSR would also be sending probes to the nearer planets, and Professor Joseph Kaplan (University of California) has been asked by COSPAR to summarise all available knowledge of conditions on Mars and Venus for the benefit of biologists.

Meanwhile, two of Kaplan's colleagues at Berkeley, in a paper sponsored by the United States Atomic Energy Commission, reported information indicating the presence in meteorites of complex organic materials related to biological processes and discussed the significance of these materials in the light of current views on the origin of life.

British work in the field of space science has been mainly concerned with satellite tracking and with the use of sounding rockets for upper atmosphere research. Lectures were given on each aspect and there was also a small exhibition of equipment developed for the experiments. The satellite tracking exhibits included radio-interferometers (Royal Aircraft Establishment and Radio Research Station) and a camera for recording satellite positions with high accuracy (Royal Radar Establishment).

In the sounding rocket section the principal exhibits were the sounding rocket Skylark and its associated equipment. Skylark was developed by the Royal Aircraft Establishment and is powered by a Raven 12,000 lb thrust solid-propellent motor. The whole vehicle weighs about 1 ton, measures 25½ ft by 17½ in (diameter) and has a payload space of 5 cu. ft behind the 15° steel nose cone. The head separates from the motor prior to re-entry into the atmosphere, and is recovered by parachute.

Cleaning and Polishing

There can be very few homes today which do not have a vacuum cleaner, and an electric one at that. New models occur with considerable frequency, each one trying to introduce some improvement that will make it just that much more useful in the house.

Since the War there has been a spate of gadgets to add to the basic suction machine. You can have a spray gun or a carpet shampoo-er; you can dry your hair, blow up the fire, reach under the lowest furniture and even add polishing brushes driven from the suction. Many, too, are the shapes—cylinder, upright, spherical, flat, and even a double cylinder. Each has its particular appeal. The price range is nearly as great.

One of the latest additions to this multitude is the Electrolux 65, a cylinder model with several improvements all aimed at simplicity and ease of operation. The makers have realised the basic principle of any piece of household equipment—that, to be used, it must save and not create work and that its use should not be attended by much fiddling preparation and aftercare.

With the "65," the electric cable is wound round the carrying handle and the grooves in the rear of the cylinder; it does not get tangled, nor does it twist if a figure of eight winding is used. Then the hose of the machine is tapered from the machine to the nozzle so that anything that will enter will also go right through without blockage. The external braiding is of pvc which is washable (and therefore suitable for hospital or similar use) and long lasting. There is also a cushioned hand grip.

A refinement is the adjustable tube. Instead of two lengths of tubing there is a single telescopic tube with a ring to lock it at the required length. It can therefore be set to suit tall or short operators and remove backache. But one of the main claims for the model is that all normal house work can be done with only two tools—one for the floors and the other for the hangings.

The single floor tool combines versions for carpet or lino. A push of the foot converts it from one to the other. It is made of aluminium casting covered with plastic, has a soft plastic buffer and nylon bristles. As with earlier models it has a swivel action to enable it to go under furniture, and it turns over to pick up fluff.

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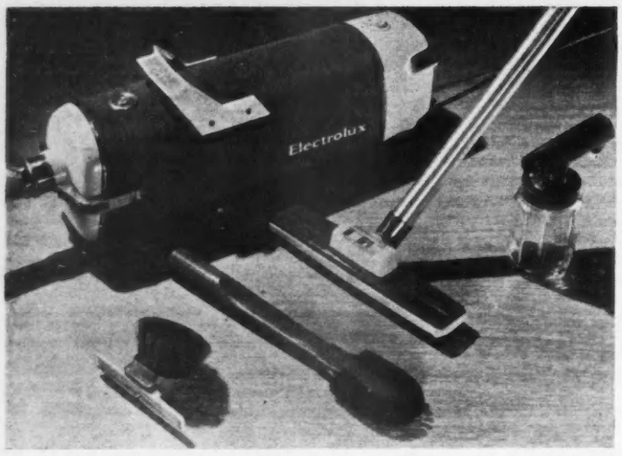
For those who have tiled or polished floors a very cheap applicator and polisher is the one shown in the second illustration. Made by Marley, the operation could hardly be more simple. The tin of DryBright polish is screwed into the head of the applicator as shown. The polish flows to the nylon pad (the process can be speeded up by pressing the bottom of the tin) and then the applicator is pushed across the floor.

The applicator is made from polystyrene with a polyurethane foam pad covered with nylon fabric. A buffer ring retains the pad and also acts as a cushion to the furniture. The makers claim that once over the floor is enough and that the polish dries bright without any additional buffing or rubbing. It is suitable for most floor coverings or for hardwoods.



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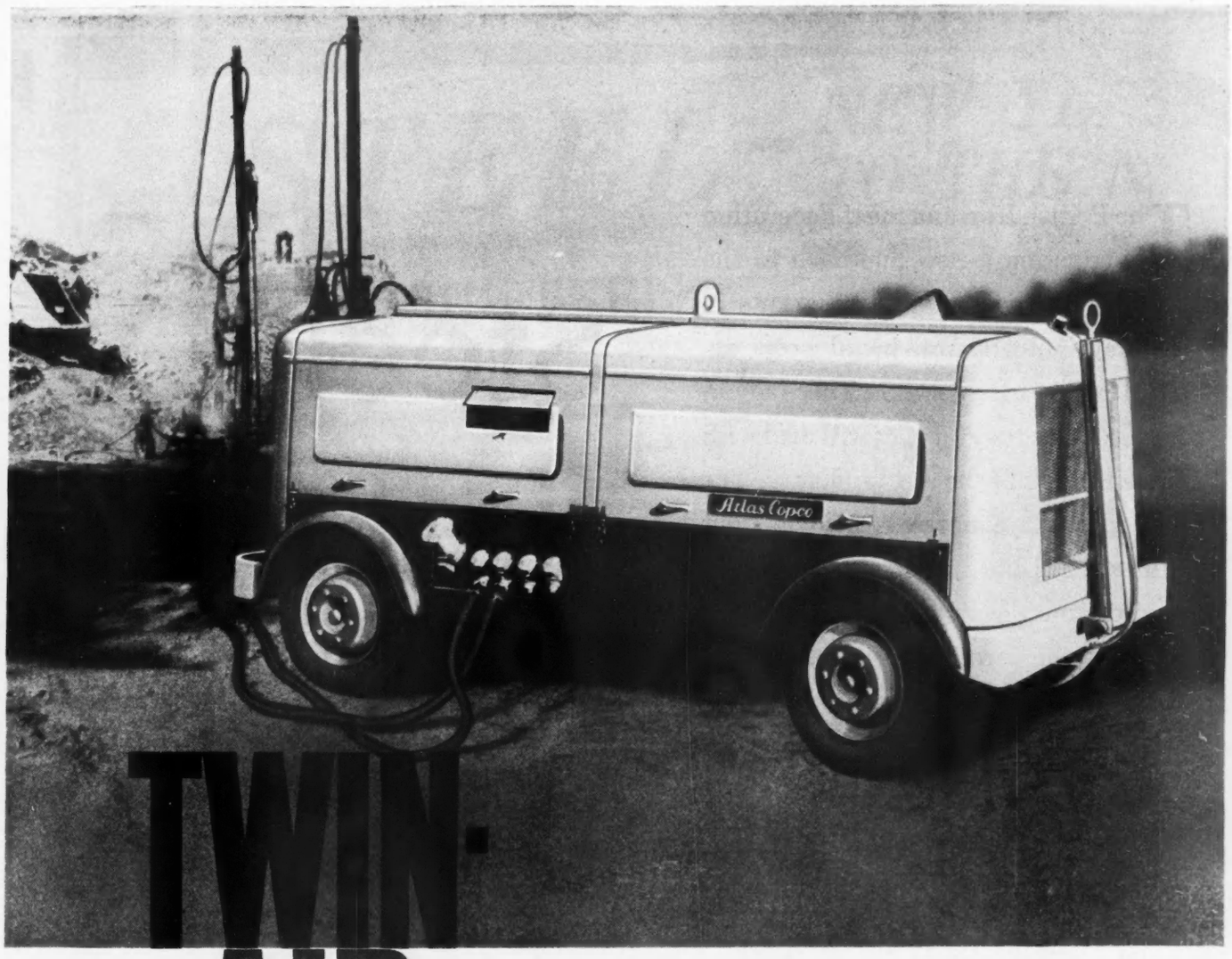

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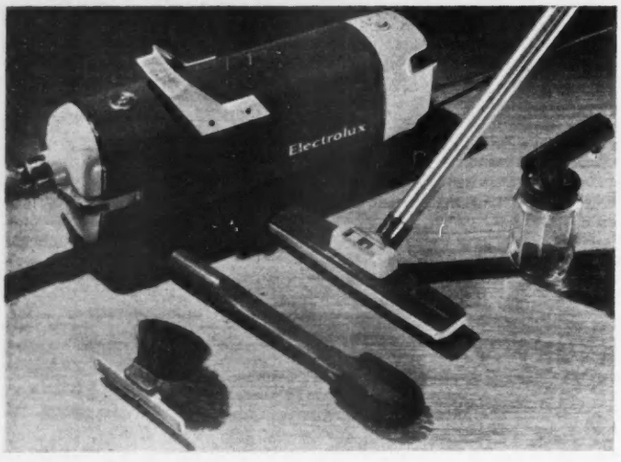

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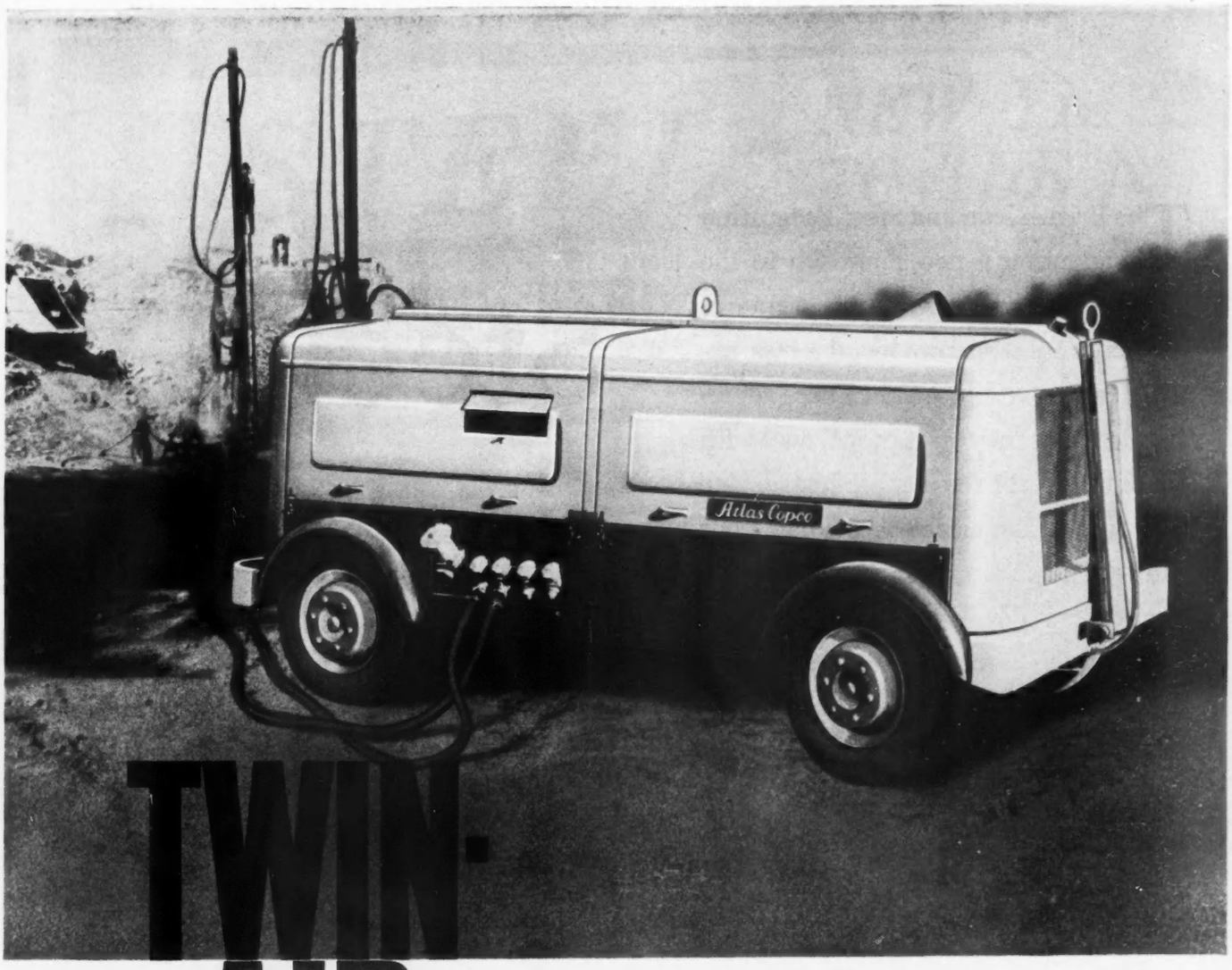

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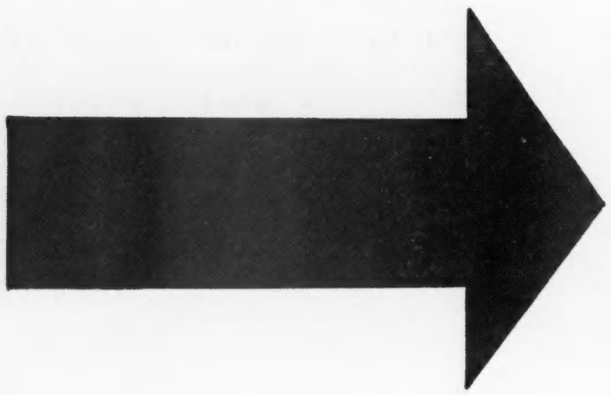
Steel's first 'Report to the Nation'

The British Iron and Steel Federation is adopting a new approach to the public in a series of advertisements in the national and provincial press entitled REPORT TO THE NATION. These advertisements, as they appear, will deal with current news of the steel industry. The first report is concerned, among other things, with the industry's production record and development plans; with some of the latest uses of steel; and with the social conditions of workers in a typical steel producing area. Future reports will explore other sides of the industry: the personalities running it; research activities; management training.

The first report has already appeared. It will be followed by others at intervals during the year, and almost everyone in the country will have a chance to see them. In this way, people can learn not only how a vital industry operates, but also how the prosperity and everyday life of the nation is bound up with that of Steel. The reports will be important, too, in helping those within Steel to know it better, and to realise they're part of an efficient, progressive and booming industry.



STEEL – NEW YE… TO THE N…

HOW MUCH STEEL IN 1960?

THE British steel industry may well produce about 24 million tons of steel in 1960—compared with 20 million tons last year.

Last year, and the year before, the steel industry spent some £100,000,000 on new plant and development—and raised its production capacity by about a *million* tons each year. This was done despite the fact that existing capacity, except in a few cases, was not being fully used.

Why this expansion, then? Is it an act of folly—or farsightedness? It is simply an expression of confidence in Britain's future.

Apart from the sharp set-back around 1958, when the industry was working far below capacity, demand for steel has shown a steady upsurge since the war. Looking forwards, the industry has weighed forecasts made by its customers about their future demand.

As a result the industry believes that the trend of steel demand will continue to rise.

Planning ahead in Steel is a ticklish business. It means foreseeing future developments in the economic life of the nation, and the changing needs of steel consumers.

Among the thousands of steel-using firms the pattern of demand can change almost overnight. But planning, building and bringing into production a new steelworks inevitably takes years.

UNEXPECTED

A plant making rails cannot change over to production of sheet for cars.

Hence in the past two years, although the steel industry as a whole has not been working at full capacity, there have sometimes been shortages of steel sheet.

Why? The causes were an unexpectedly swift boom in cars – which took even the motor industry itself by surprise; rising sales of household goods like cookers and washing machines, and of electrical machinery; and a shift in demand from one kind of steel sheet to another.

£760 MILLION

Not even the wisest brains can predict, years ahead, every future shift in the pattern of demand. But Britain's steel industry has done remarkably well since the war in having the right plant ready at the right time.

Since the end of 1946, a sum of over £760,000,000 has been spent on development. The graphs show the crescendo of expansion in the last seven years; and also how the steel industry, far from lagging, has gone ahead faster than other manufacturing industries.

NEW MILLS

In the critical field of cold reduced sheet, production in 1959 was 13% up on 1958, and will rise again by perhaps as much as 20% in 1960. Further expansion at existing strip mills and construction of two new mills at Newport and Ravenscraig, work on which is being accelerated, will meet the likely demand for sheet and tinplate.

What of the other sections of the industry? Although hit by the recession, they have pressed on with expansion. The new Universal Beam Mill at Lackenby, best of its kind in the world, is in production – indeed, everywhere the nationwide programme of steel development is accelerating. At the lowest point (December, 1958) the industry was operating, on average, at about 70% of capacity. Now the rate is over 90% – of a greater capacity.

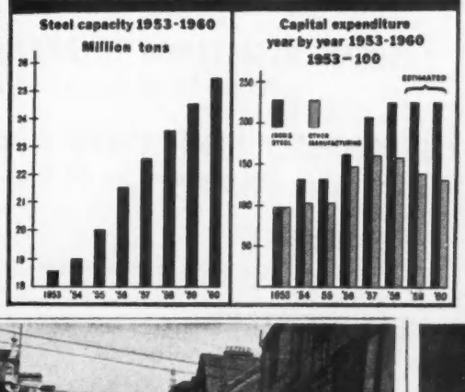
UP AND UP

Prospects are that there will still be some margin of capacity in 1960 in certain heavy steel products, as a result of continued slackness of demand from railways, coal mines, and shipbuilders. But demand for other types of steel is expected to rise still further.

Steel production in 1960 may therefore be between three and four million tons more than in 1959.

Continued modernisation and expansion – at a cost of over £100 million a year – will provide an efficient steel capacity of over 30 million tons by 1965, a sound basis for competing in world markets.

SEVEN YEARS OF STEADY PROGRESS



SIXTY KINDS OF STEEL ON T…

Steel takes these shock…

THEY do brutal things to a car, down at Nuneaton, on the proving grounds of the Motor Industry Research Association. And every time they test a car, sixty different kinds of steel are on trial. That's how many there are in a modern car.

One of the tortures have devised consist pavé track made of stone blocks, set angles, with pier pot-holes. They li drive cars across it.

And what bears brunt of this savage

Fifty…

New life in the Valleys

BY TREVOR EVANS

THE "black years" of the 'twenties and 'thirties are not yet forgotten in South Wales. So it was with deep misgivings that I went back to the village where I grew up.

I was never so surprised in my life. I rubbed my eyes, thinking for a moment that I had driven into the wr…

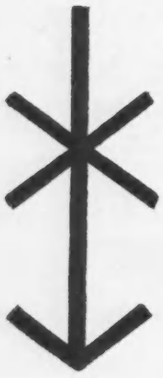
THE BRITISH IRON AND STEEL FEDERATION

ALAG

A special aggregate for special purposes

New!*

ALAG is a synthetic aggregate which, when used with CIMENT FONDU, PRODUCES CONCRETE WITH THE FOLLOWING UNIQUE PROPERTIES:



EXTREME RESISTANCE TO ABRASION
(Hardness of aggregate 7·5 MOHS Cuts glass)

ENORMOUSLY HIGH STRENGTH IN A MATTER OF HOURS
(For example 12,000 lb per sq. inch at 24 hours and 16,000 lb per sq. inch at 7 days)

HIGH DENSITY
(167 lb per cu. ft. air-dried—20lb per cu. ft. higher than normal).

HEAT-RESISTANT
(up to 1150/1200°C)

OR ALL ABOVE PROPERTIES COMBINED

SHOULD BE USED ONLY WITH HIGH ALUMINA CEMENT (CIMENT FONDU)

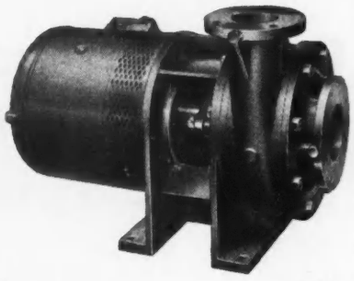
Write for further information. ALAG is available only from:—

LAFARGE ALUMINOUS CEMENT COMPANY LIMITED

73 Brook Street, London, W.1. Telephone : Mayfair 8546

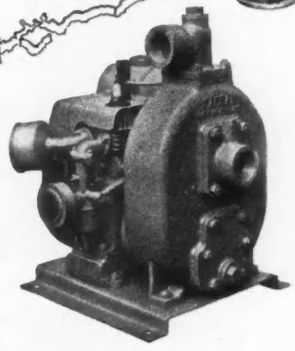
When you need Pumps QUICKLY take advantage of

SAFRAN
REGISTERED TRADE MARK
PUMPS



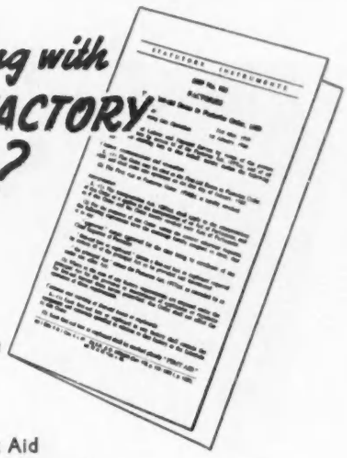
INTER-STOCKING PLAN

In an emergency telephone the nearest address alongside



SAUNDERS VALVE CO. LTD.,
SAFRAN PUMP DIVISION
DRAYTON STREET,
WOLVERHAMPTON

Are you complying with these REVISED FACTORY REGULATIONS?



Revised regulations regarding First Aid in Factories are effective from 1st January 1960.

As the Pioneers of Industrial First Aid we offer approved complete First Aid Outfits to meet the requirements of all trades.

Please state number of employees and nature of business when ordering.

Full details are available to responsible officials applying on their company's letterhead, mentioning this "Engineering" announcement.

CUXSON, GERRARD & CO. LTD.
OLDBURY, BIRMINGHAM
Telephone : BROADWELL 1355 (4 lines)

'DELTA'

THE
LEADING NAME
IN
NON-FERROUS
METALS AND ALLOYS
FOR OVER
THREE-QUARTERS
OF A
CENTURY

★

BRASS · BRONZE · COPPER
ALUMINIUM & ALUMINIUM ALLOYS

IN
RODS
BARS
STRIP
TUBES
FORGINGS
AND EXTRUDED SECTIONS ETC.

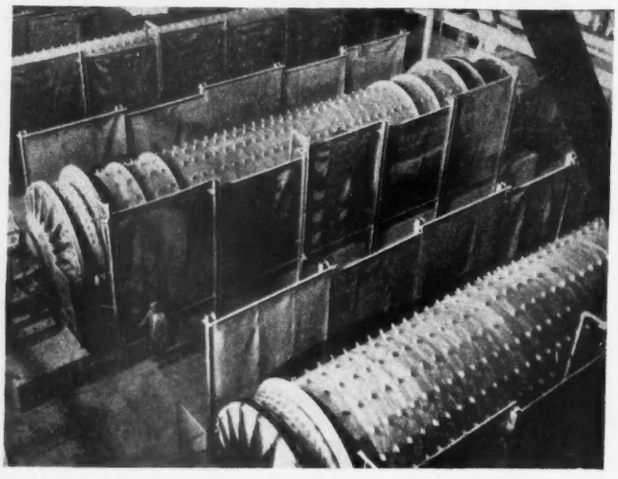
—ORIGINATORS OF THE EXTRUSION PROCESS—

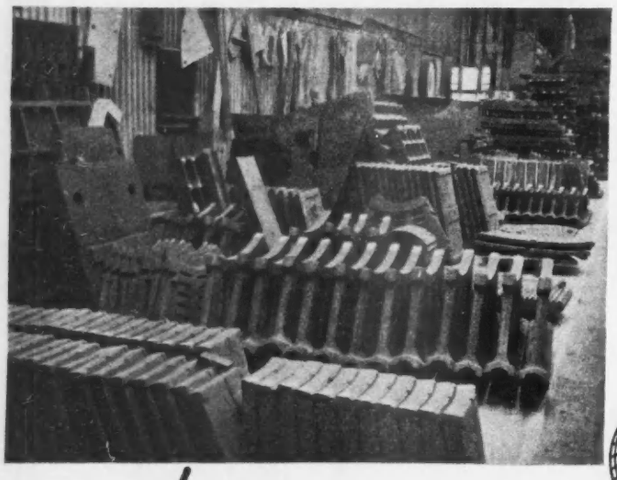
THE DELTA METAL COMPANY Ltd., LONDON & BIRMINGHAM
AND ASSOCIATED COMPANIES

The latest techniques in the Cement and Crushing Industries . . .

Plate diaphragm for Compound Cement Mill

demand the latest techniques in special Alloy Steel Castings



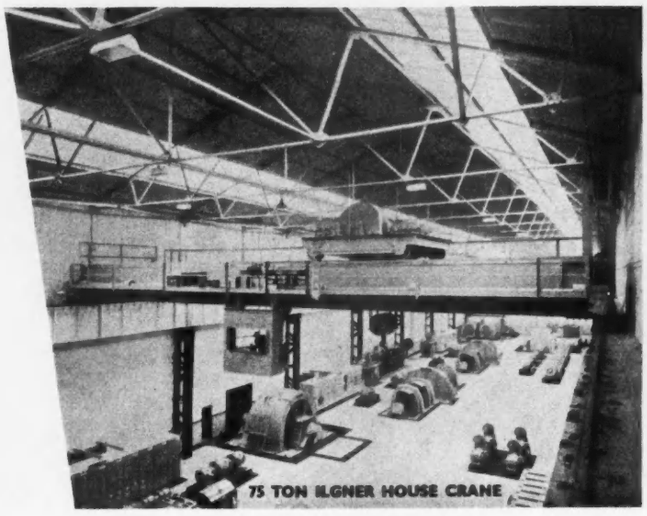


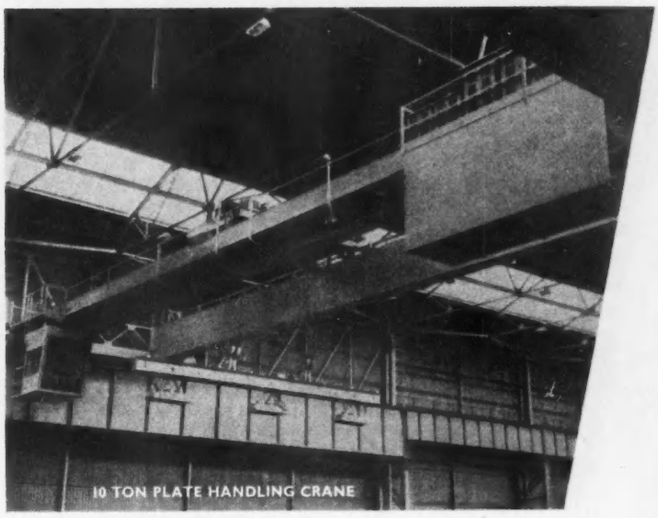
by

FIRTH BROWN

ALLOY STEELMAKERS · FORGEMASTERS · STEEL FOUNDERS HEAVY ENGINEERS

THOS FIRTH & JOHN BROWN LIMITED SCUNTHORPE ENGLAND


75 TON ILGNER HOUSE CRANE


10 TON PLATE HANDLING CRANE

* ***Simplified Maintenance.***

Engineered for Steelworks and other tough usage.

'Multival' Lubrication supplied as standard.

Fatigue free operation ensuring efficiency of the operator.

Clean modern lines.

Cranes of any size and capacity.

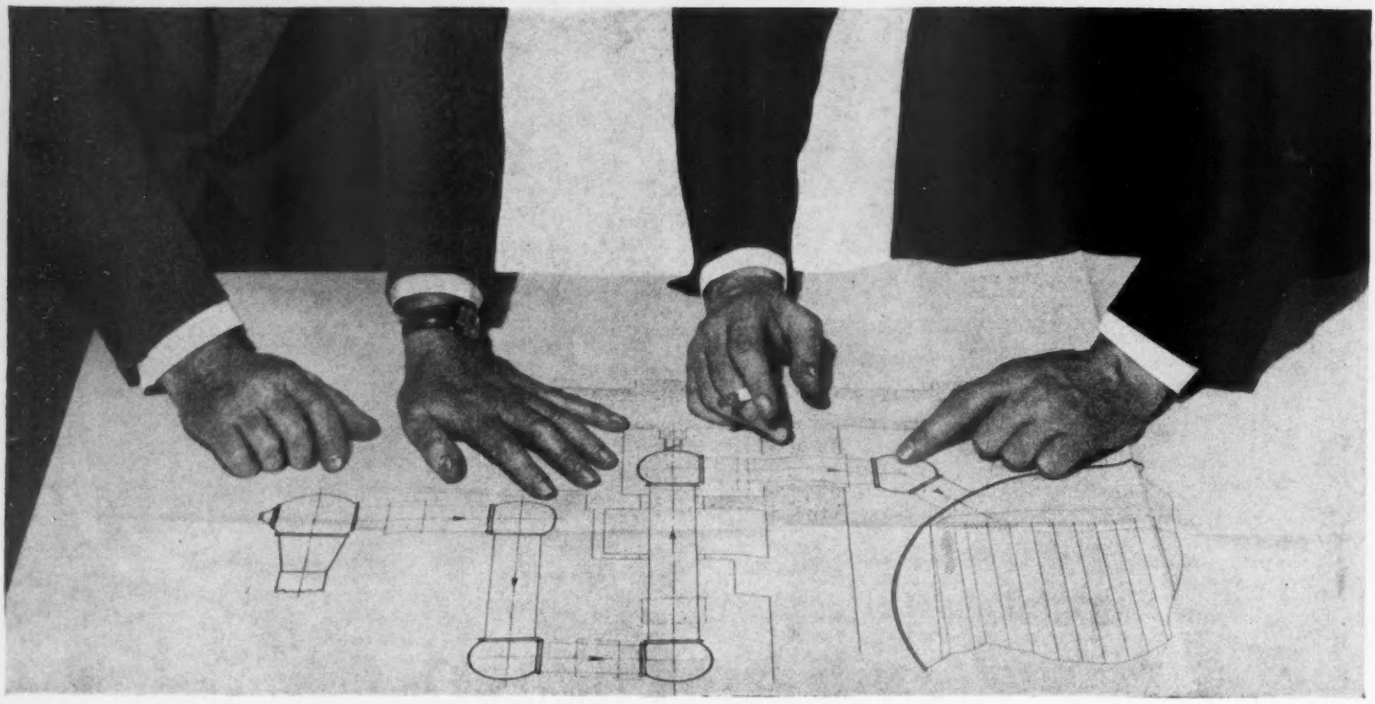
PLUS

FIRST CLASS AFTER SALES SERVICE FROM:

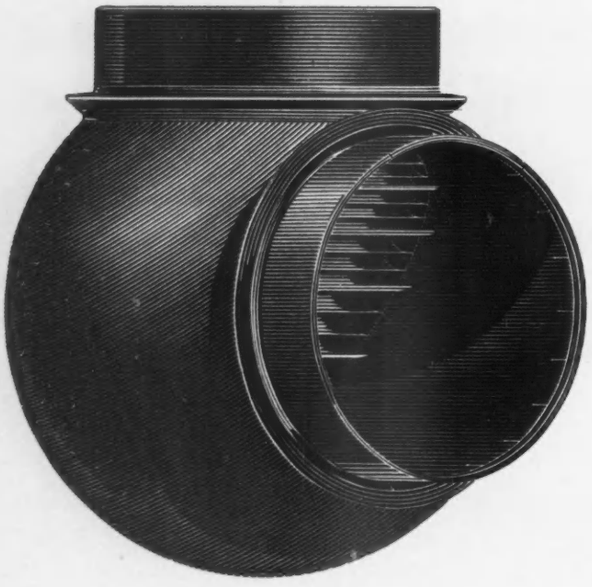
carruthers

30/10 TON GOLIATH CRANE

J. H. CARRUTHERS & CO. LTD., COLLEGE MILTON, EAST KILBRIDE, GLASGOW. Telephone: East Kilbride 20591, Telephone: Hoisting, East Kilbride



YOU COULD HEAR A PENNY DROP...



We spread out the drawings . . . an instant of surprised silence; then that gratifying sound. It is usually something like "Of course! Why didn't somebody think of that before."

Why not indeed? All we have done is to make the bends in the CO_2 pipework of an atomic reactor, spherical. Any schoolboy with G.C.E. physics knows the formula for the thickness of a pressure vessel—

Cylindrical: $t = \frac{P.R.}{S}$ Spherical: $t = \frac{1}{2}\frac{P.R.}{S}$

So with a sphere you can halve the thickness of the plate. But that is only the beginning. Bonuses roll in. All welds become circular, can be made by machine and can be X-rayed easily and completely. There are no uncertainties—no stiffening webs, for instance, attached by welds which cannot be X-rayed. The guide vanes are part of a lightweight duct, inside the sphere and thus unstressed by pressure.

A simple and indeed an obvious idea; but it can save large sums of money on the cost of a power station or a wind tunnel. The fact is it is not easy to see the obvious; the orthodox approach, the standard answer, get in the way. However, some of our engineers seem to be able to do it, thank goodness.

RICHARDSONS, WESTGARTH & CO. LTD.

Wallsend, Northumberland and at 58 Victoria Street, London, S.W.1.

The controlling Company of the RICHARDSONS WESTGARTH GROUP, co-ordinating the activities of:—

THE NORTH EASTERN MARINE ENGINEERING CO. LTD.
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RICHARDSONS WESTGARTH, INC.

ASSOCIATED COMPANY: ATOMIC POWER CONSTRUCTIONS LTD.

RW53

Do you wait for hot water on a cold Monday morning?

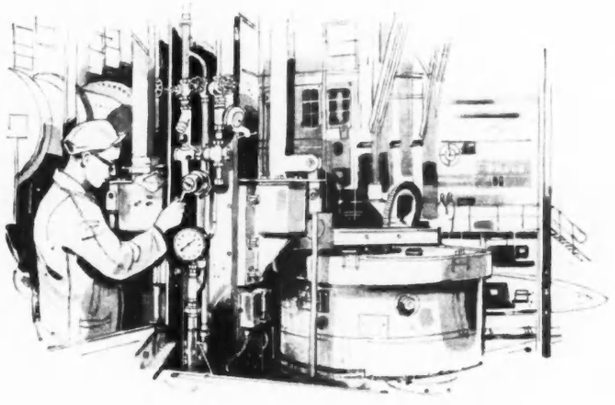
Where hot water is provided from a storage system there is a waiting period when production starts, for the water to heat up in the storage tanks.
With Leonard Steam Water Mixers there is no waiting period. Hot water is available as soon as the steam is turned on.

Do you use cold water when you would like to use hot?

When vegetables are cleaned for canning they are washed in a running stream of water. If the water is too cold the girls' fingers get numb and their production slows down. If it is too hot the vegetables are spoilt. A Leonard Valve looks after the temperature, the girls' fingers and the vegetables.

How would you raise the temperature of a spray very gradually from cold to 120 degrees?

Leonard Valves fitted to the sparge pipe on a cloth scouring and milling machine enable the scourer to vary the temperature to suit the work and to make changes in the temperature during the process gradually, giving a cleaner scour and a better finish.



These are specific examples. Your use of Leonard Thermostatic Steam Water Heaters will probably be different. Write for help. (Our folder H/6)

WALKER CROSWELLER & CO. LTD.
Cheltenham
Telephone Cheltenham 56317

29,120 lbs Pressure for only £175 Cash!

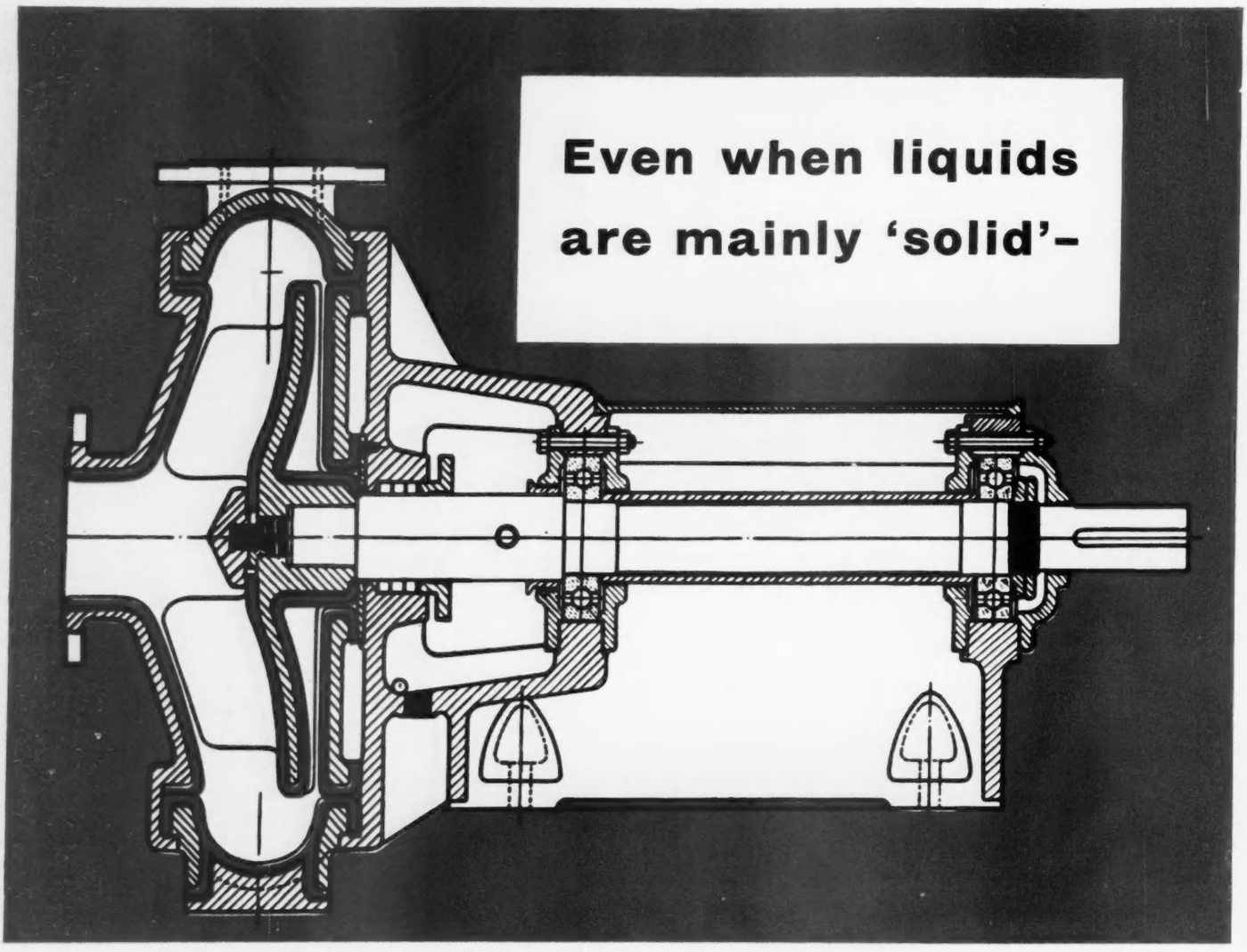
This formidable Hydraulic Cropper can cut, for instance, 2" x ½", 3" x ⅜" and 4" x ¼" thick Flat Mild Steel in one stroke and also ¼" thick Sheet and Plate to any width and all controlled by the simple pressure of the foot. It's speedy, for you can get up to 34 cuts per minute with only negligible burr. It is only 3' 0" x 1' 0" x 5' 0" high and weighs but 5 cwts.

A really economical "buy" at only £175 ex works.

PILOT

PILOT WORKS LTD.
Manchester Road, Bolton.
Tel: Bolton 5545

LONDON OFFICE
3 Southampton Place, W.C.1
Tel: CHA 5130



–the VACSEAL gives continuous, trouble-free pumping

Slurries containing up to 70% solids can be handled continuously and safely by the VACSEAL PUMP. Its unique design is the simplest ever devised for solids handling. Fluids, abrasives and corrosives cannot enter glands or bearings. *No sealing water* — the pump is virtually glandless.

Pump sizes 1½ in.—8 in. inclusive • Capacities 10 to 2,500 galls./min. and delivery against heads up to 100 ft. • Suction lift 12 ft. • Quick delivery • Standard rubber linings for mining pulps, and gritty suspensions • FERLOY *metal lining for liquids with solids exceeding ⅜ in. cube • Special rubber linings for acids and other corrosives • Larger all-metal types for ash-sluice and gravel pumping.*

Please write for Booklet G.549

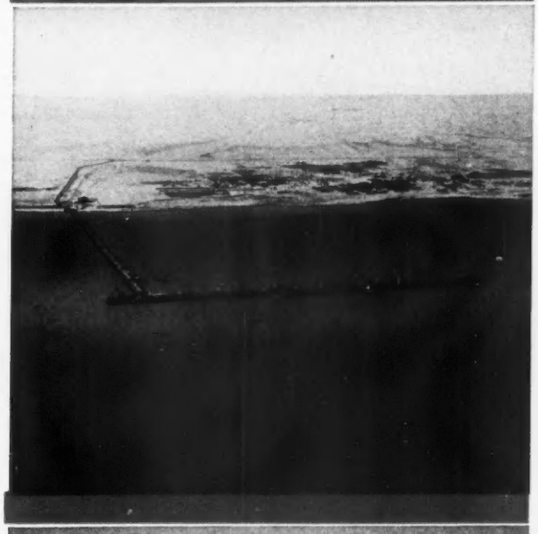
'Vacseal' and 'Ferloy' are registered trade names of International Combustion Products Ltd.

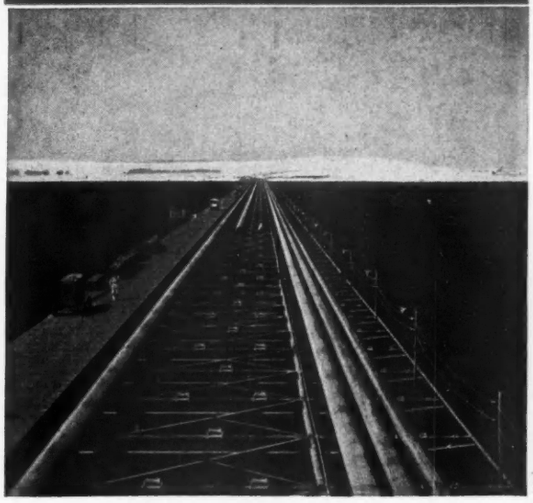
INTERNATIONAL COMBUSTION PRODUCTS LIMITED

NINETEEN WOBURN PLACE, LONDON WC1 TERMINUS 2833 WORKS: DERBY

Member of Atomic Power Constructions Limited. One of the five British Nuclear Energy Groups.

TGA V16





South Durham

at Mina al Ahmadi

For the construction of the Kuwait Oil Company's new North Pier at Mina al Ahmadi, Kuwait, and for extensions to its refinery, South Durham have been privileged to supply over 48,000 tons of steel made up as follows:

PIER PILES	**Tons**
"RENDHEX" FOUNDATION COLUMNS	**13,500**
PLAIN BROAD FLANGE BEAMS	**850**
TWIN BROAD FLANGE BEAMS	**2,030**
BROAD FLANGE BEAMS with plates welded to flanges	**2,640**
PIER DECKING	
BROAD FLANGE BEAMS (plain and plated)	**2,700**
EXTENSIONS TO REFINERY; NORTH PIER; TRANSIT AND GRAVITY LINES	
MILD STEEL PIPES from 18 inches to 40 inches diameter, automatically welded by the Submerged-Arc Process to A.P.I.5L Specification (approximately 100 miles)	**27,000**
Total tons	**48,720**

The pier is carried throughout its length on South Durham "Rendhex" Foundation Columns. Before shipment these columns were specially prepared at the South Durham Works where also all decking steelwork was prefabricated for welding on site. The total quantity of steel was shipped over a period of fifteen months. Another example of the way in which South Durham is "circling the globe with steel."

SOUTH DURHAM STEEL AND IRON COMPANY LIMITED

Central Sales Office: **CARGO FLEET IRON WORKS, MIDDLESBROUGH, YORKS.**

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'U' RINGS · SQUARE-SECTIONED RINGS
MOULDINGS AND BONDINGS

Natural, synthetic
and silicone rubbers

DOWTY SEALS LIMITED · ASHCHURCH · GLOS.

controlled quality..

Repetition steel castings for the Railway Modernisation Programme

SPROTBOROUGH FOUNDRY

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Impact-tested

Pilkingtons' 'Armourplate' Glass

For strength with vision

A bombardment with steel balls (using modern apparatus!) is one of the tests applied to Pilkingtons' 'Armourplate' Toughened Glass. The allowable working stress for 'Armourplate' is from 6,000 to 6,500 lb per square inch, but in special circumstances a much higher stress can be allowed confidently. With its mechanical and thermal strength coupled with clear undistorted vision 'Armourplate' is the ideal material for many industrial and engineering applications.
For further information consult Pilkingtons' Technical Sales and Service Department.

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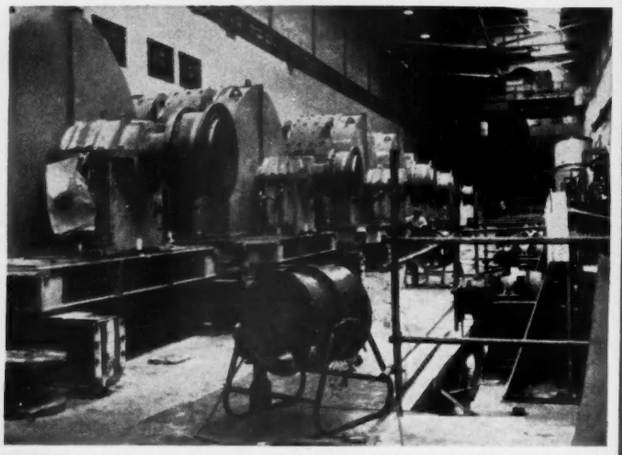
'ARMOURPLATE' is a registered trade mark of Pilkington Brothers Limited
Supplies are available through the usual trade channels

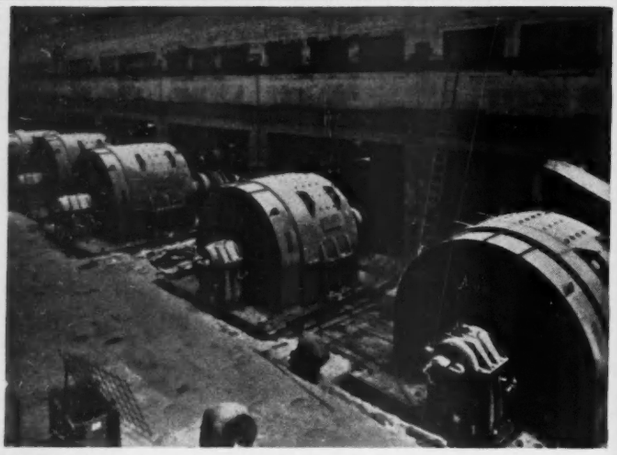
Target beaten in

At the Ebbw Vale Steelworks of Richard Thomas and Baldwins Limited re-motoring of the continuous hot strip mill was accomplished in only 19 days—one day ahead of schedule. This operation involved the removal of 1,500 tons of equipment and its replacement by new machinery.

The G.E.C., as the main contractors for the finishing mill electrical work, operated in close collaboration with Richard Thomas and Baldwins Limited and the Consulting Engineers, McLellan and Partners. The contract covered the supply and erection of the main drive motors, rectifiers, transformers, d.c. circuit breakers and all protective, control and instrumentation equipment for the finishing mill.



1. With the new, more powerful motors lined up behind the old, and with much of the associated equipment already installed, everything was set for the changeover.



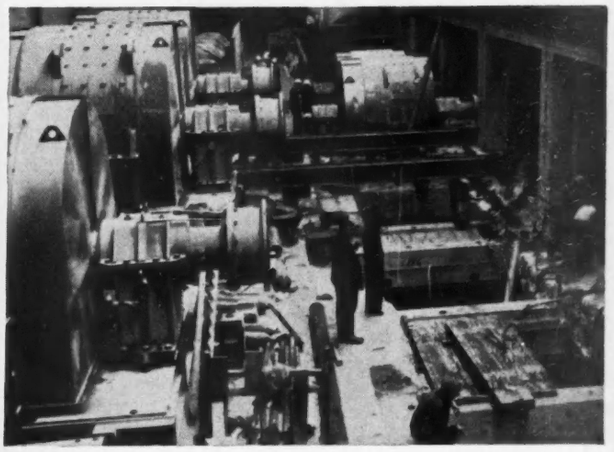
4. The mill couplings were then fitted. The new total of 23,000 horsepower will give the finishing mill a substantially higher output than the former capacity of 16,000 tons per week.

5. From the new, wide-view pulpit, the operators control the rolling operations. The mill voltage is automatically set up and checked by means of indicator lamps which show when each operation in the sequence is complete.

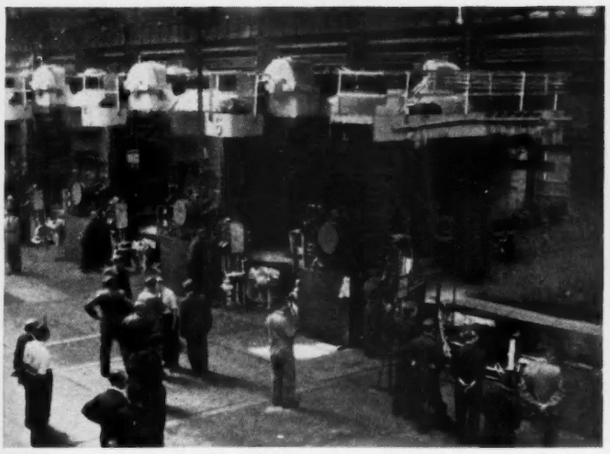
G.E.C. OF ENGLAND

mill re-motoring

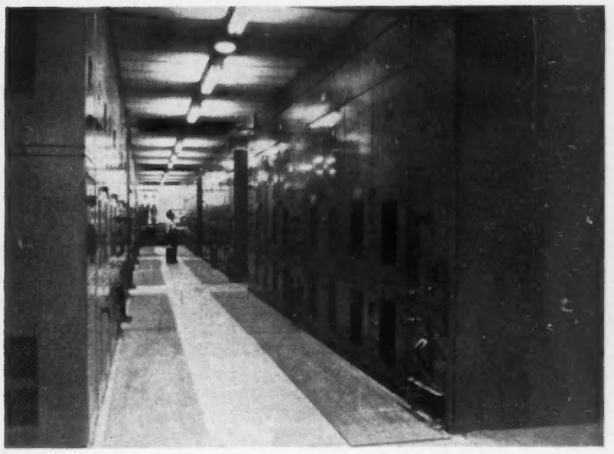
2. Work started at 9 a.m. on August 1st, within minutes of the last strip passing over the run-out table, and foundations were quickly prepared for the new machines.



3. Work went on all round the clock. Winches were used to slide 480 tons of motors on heavy beams across the motor room and the machines were lowered on to the foundations.



6. At 12.40 p.m. on August 20th the mill commenced rolling, so bringing the changeover to a successful conclusion in record time.

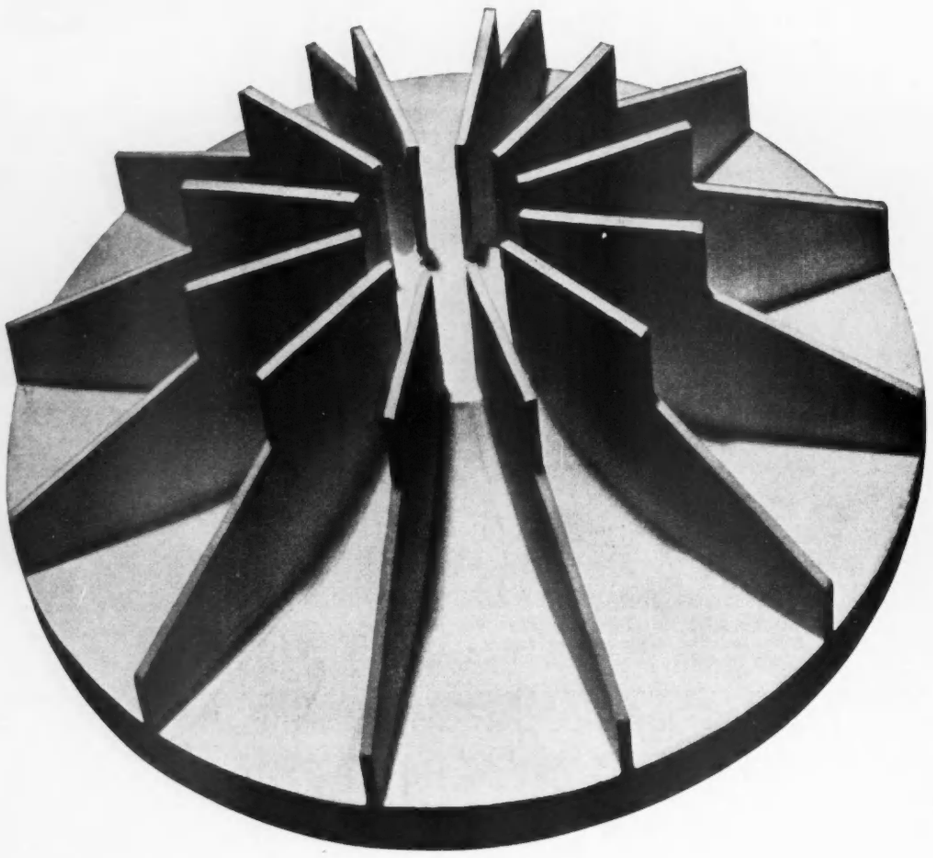


7. More than 60 tons of busbars and cables link the motors, the control gear and 19,800 kW of grid-controlled rectifiers which provide power for the finishing train.

THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND

Plant Co-ordination Division, Birmingham, 6

THE SPECIAL TECHNIQUES OF H.D.A.



Precision Forging means exactly what it says—forging to such very fine tolerances that often no machining is required. Components such as the impeller shown here can be used in the 'as forged' condition. **This saves time; this saves money; this saves effort. H.D.A. can do it.**

(Forging in Hiduminium 42 for Simms Motor & Electronics Corporation Ltd.)

Hiduminium

makes the most of *Aluminium*

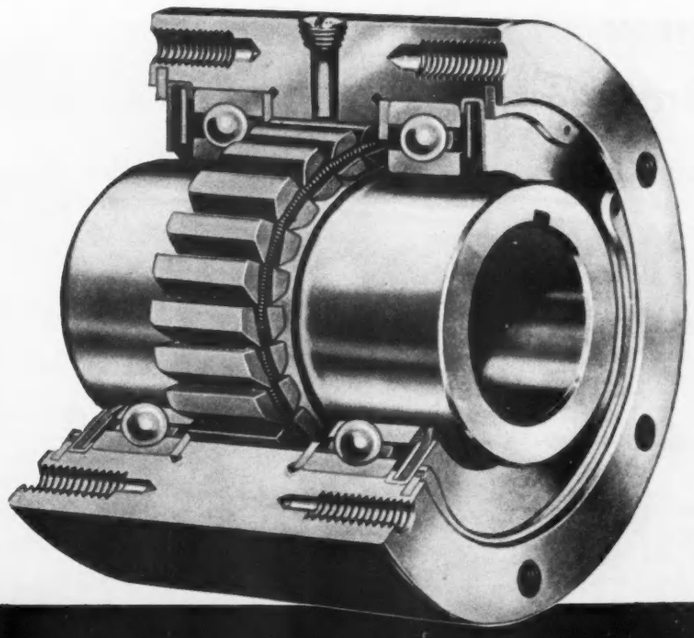
HIGH DUTY ALLOYS LTD. SLOUGH, BUCKS.

★ **for fast and accurate indexing**

★ **for continuous freewheeling with low drag**

★ **for backstopping — non-reversibility without backlash**

specify



RENOLD SPRAG clutches

The Renold Sprag Clutch with its full complement of precision made sprags self-contained between concentric races, transmits maximum torque in minimum space. Backlash is virtually eliminated as there is no necessity for the clearances required in alternative mechanisms.

For quiet, frictionless over-running — accurate indexing — instantaneous backstopping — and any combination of these basic applications — the Renold Sprag Clutch is unequalled.

Standard clutches have bore sizes ranging from .25" to 12.0" and torque capacities from 50 lb./in. to 136,000 lb./ft. A special design service is available to deal with requirements outside the standard range.

Sprag clutches are manufactured under licence from Formsprag Company, U.S.A.

For further information write for Catalogue Ref. 116/35 or ring for our sales engineer to call

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for ALUMINIUM RE-MELTING FURNACES

PRIEST FURNACES LIMITED
LONGLANDS MIDDLESBROUGH

F 147

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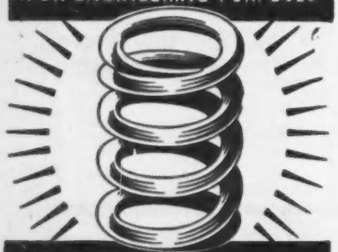

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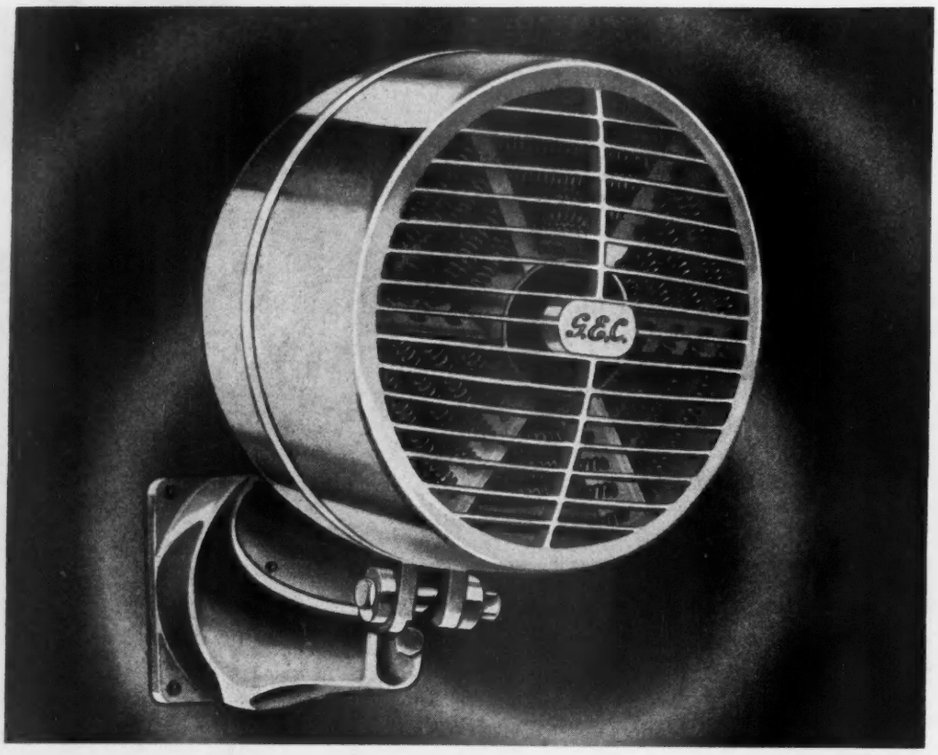

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This control unit provides thermostatic control for the 3kW heater (illustrated here) and also switching for the fan to be used for cooling in warm weather.

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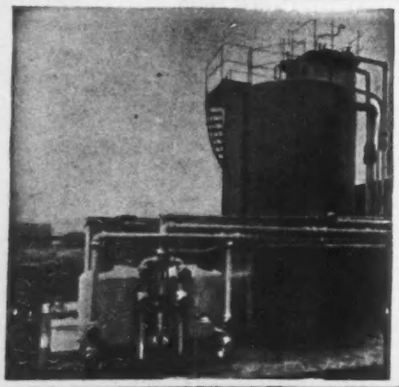

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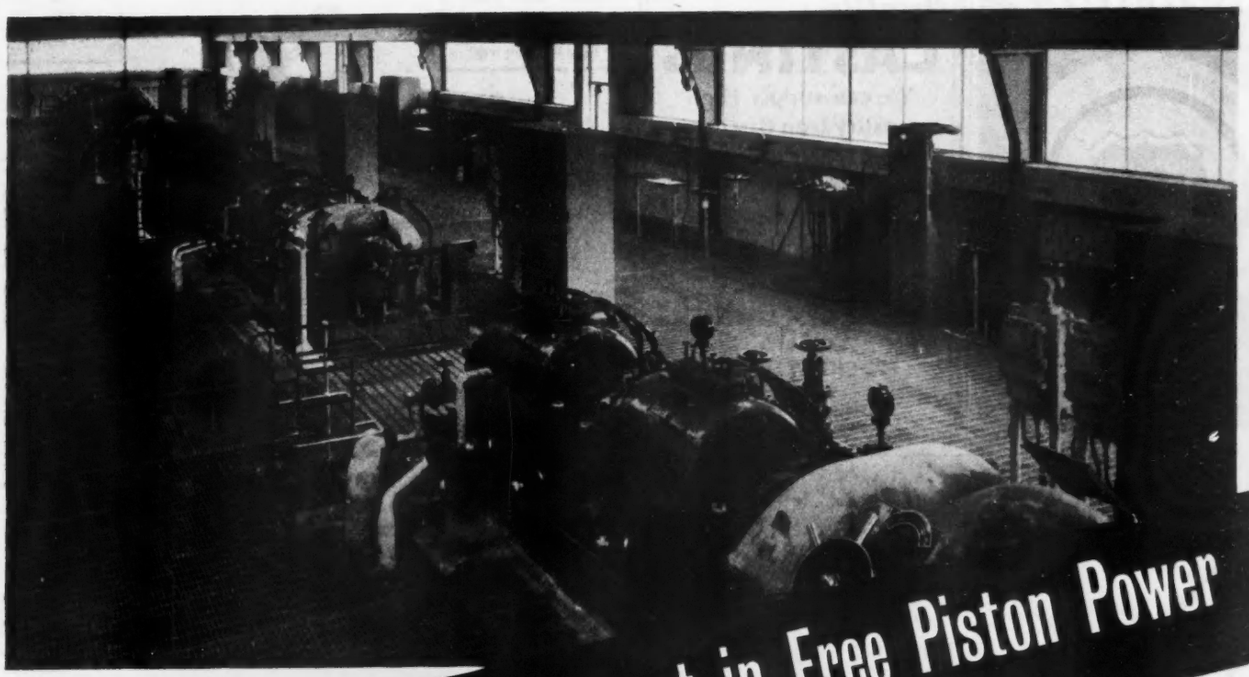

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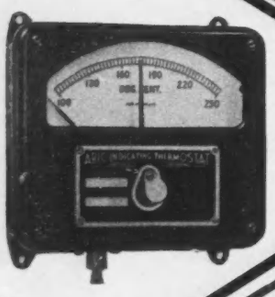

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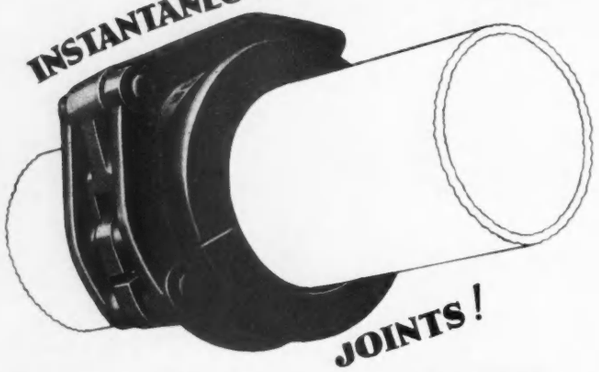

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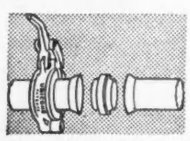
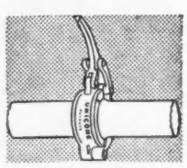
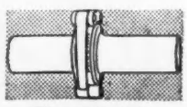


Rubber gasket in position and joint ready to pull over



Pipe ends joined ready for locking



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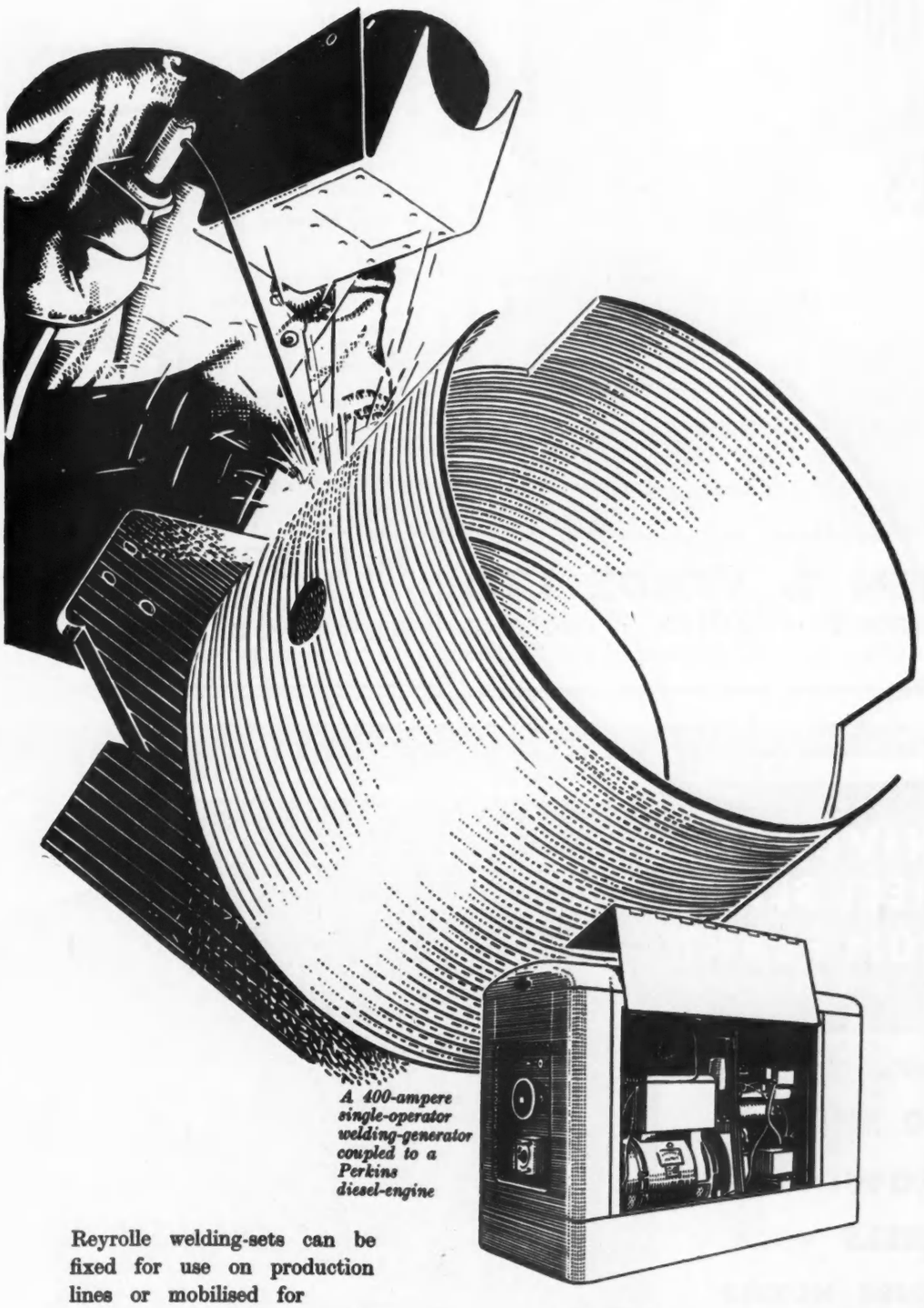

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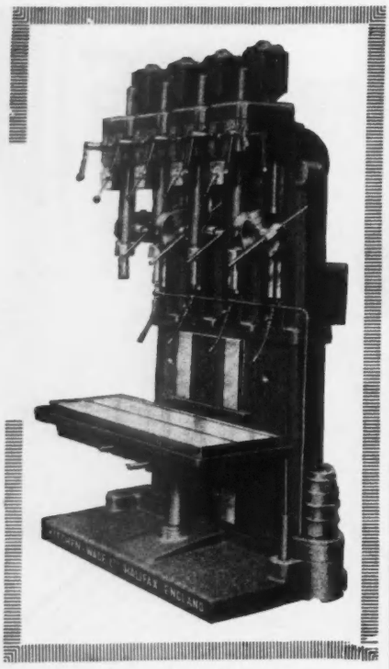

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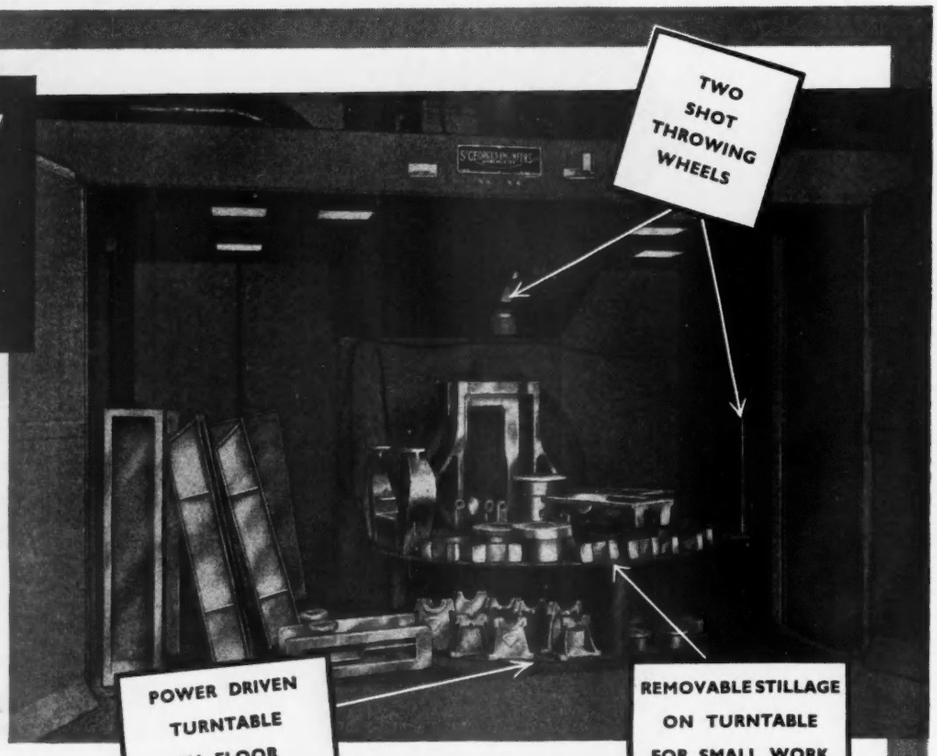

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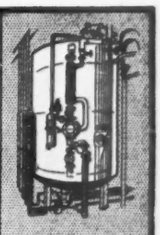

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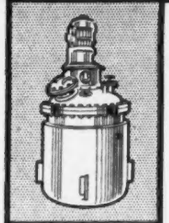

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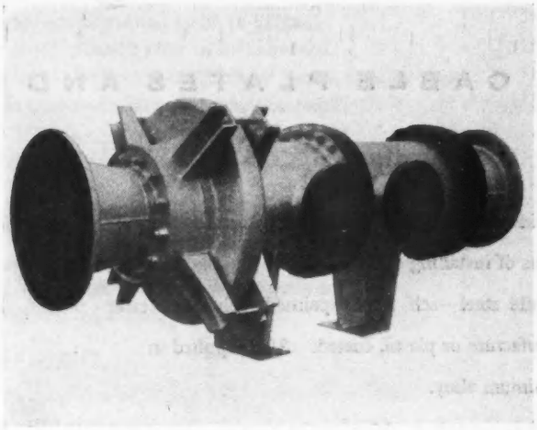
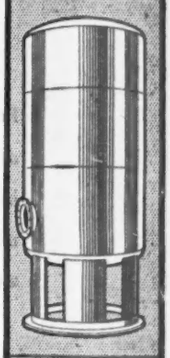


One of a number of specially constructed Heat Exchangers



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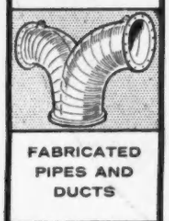

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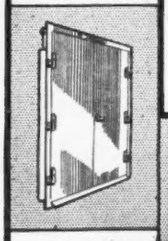

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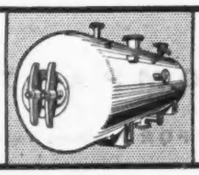
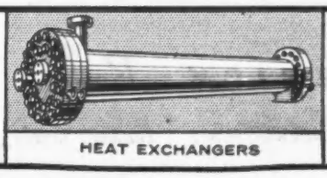


PRESSURE VESSELS



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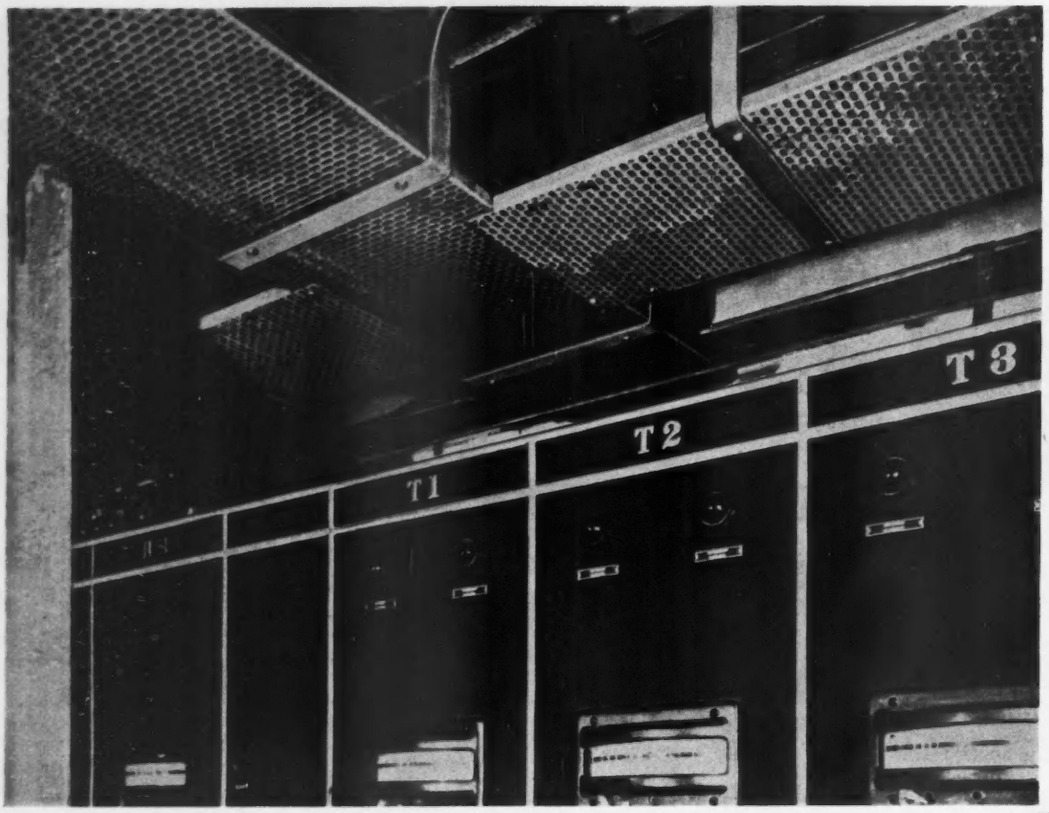

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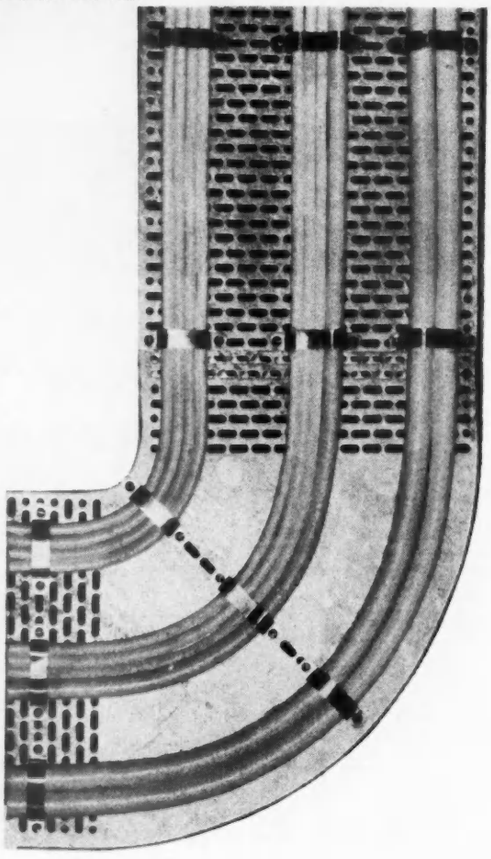

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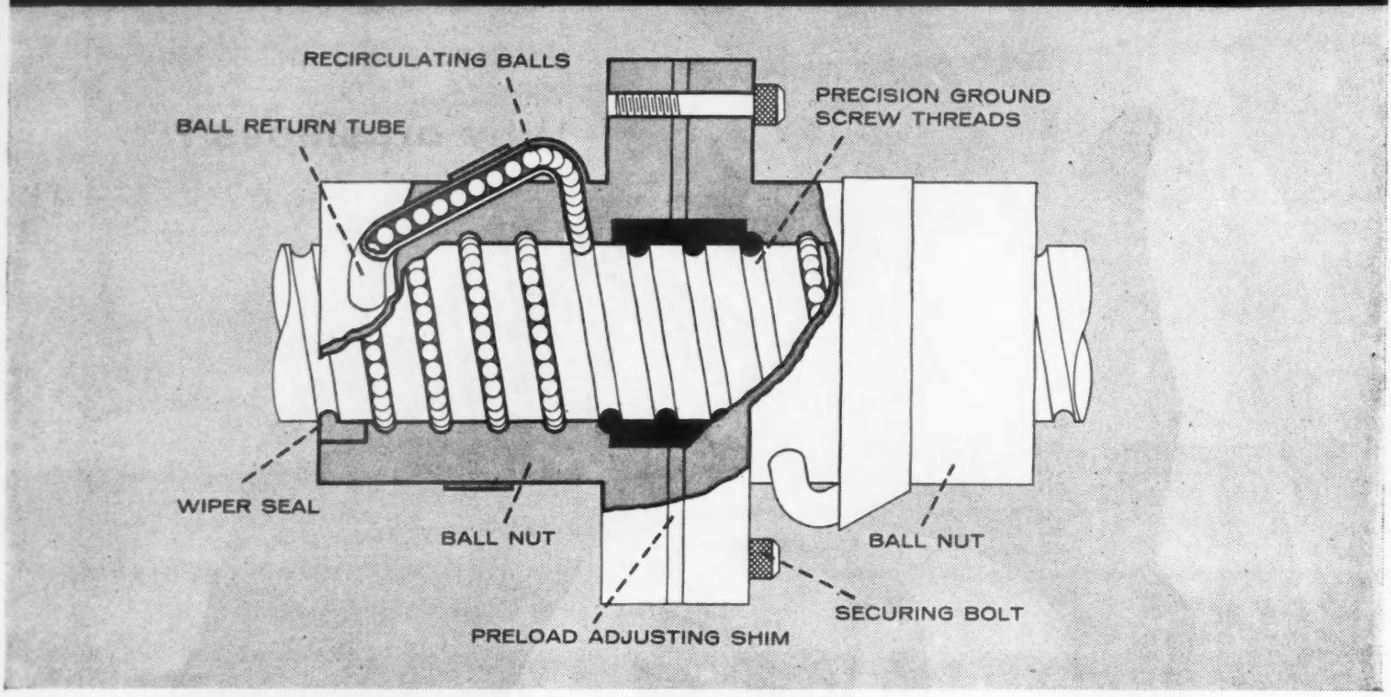

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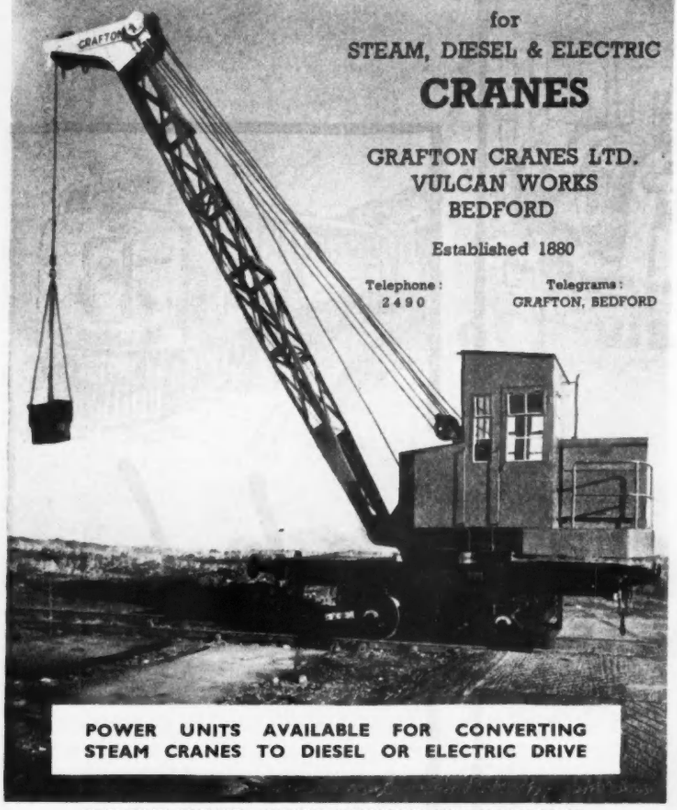

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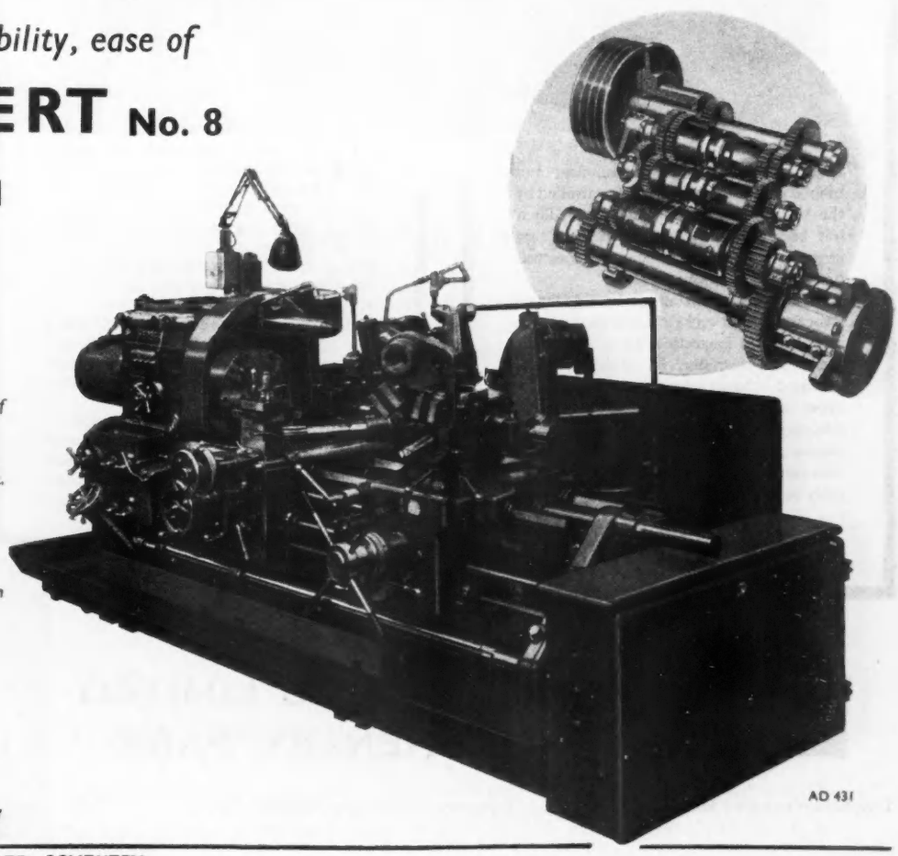

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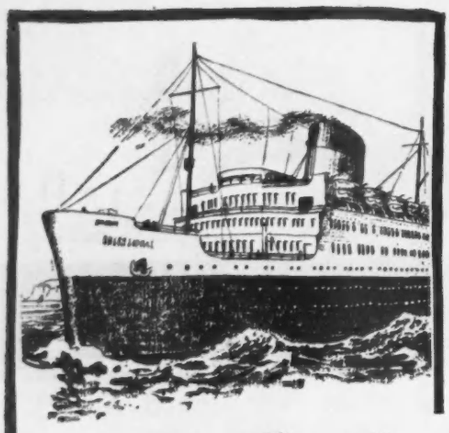

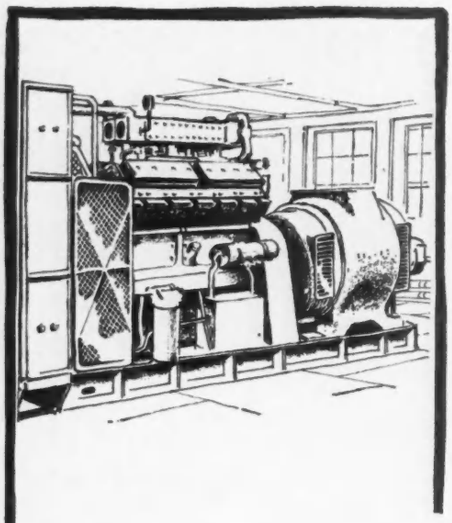

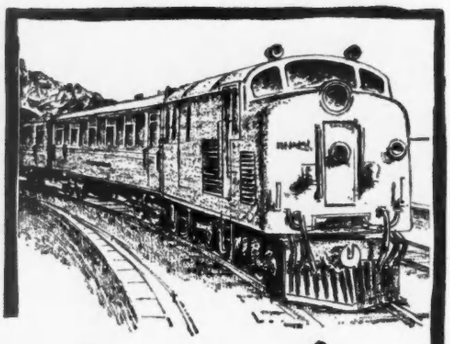

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Vokes Silencers—Brief Technical Data

N.C.2. Exhaust Silencer—in sizes from 44″ to 208″ overall length.

N.C.3. Exhaust Silencer (as N.C.2 but with side entry)—in sizes from 44″ to 220″.

N.C.4. Spark Arrestor Silencer—in sizes from 50½″ to 266½″.

N.C.5. Spark Arrestor Silencer (as N.C.4 but with side entry)—in sizes from 50½″ to 277⅞″.

The pressure drop across the N.C. 2 & 3 is approximately 3½ Velocity Heads, and across the N.C. 4 & 5, 4½ Velocity Heads, based on the mean velocity in the inlet pipe.

N.C.S.P.3 Splitter Absorption Silencer—in sizes from 60″ to 114″. Available with rectangular or circular flange connections. Standard models are capable of accommodating temperatures up to 1000°F.

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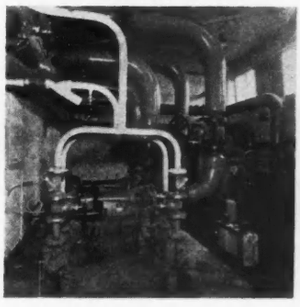
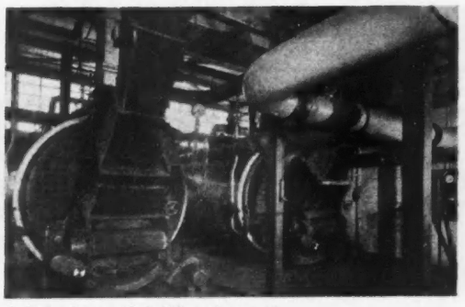


Two double pass economic boilers, each 6,000,000 B.t.u's per hr—chain grate stokers and coal and ash handling plant.



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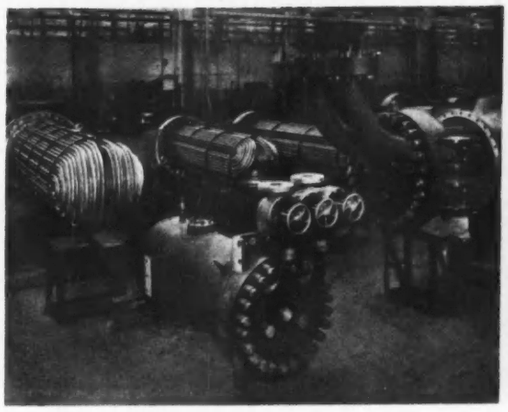

H & W solid drawn copper tubes used in construction of Weir Marine Feed Water Heaters. (Photograph by courtesy of Messrs. G. & J. Weir Limited.)

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Fitting "Hudal" aluminium brass tubes in Weir Three-stage Air Ejector for the liner "Reina del Mar". (Photograph by courtesy of Messrs. G. & J. Weir Limited.)

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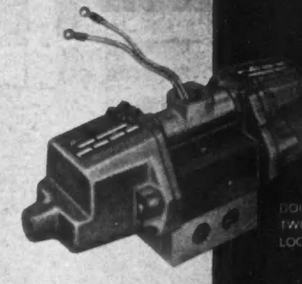

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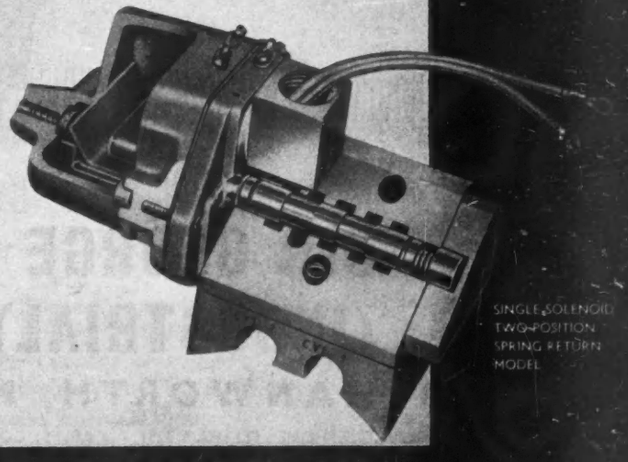

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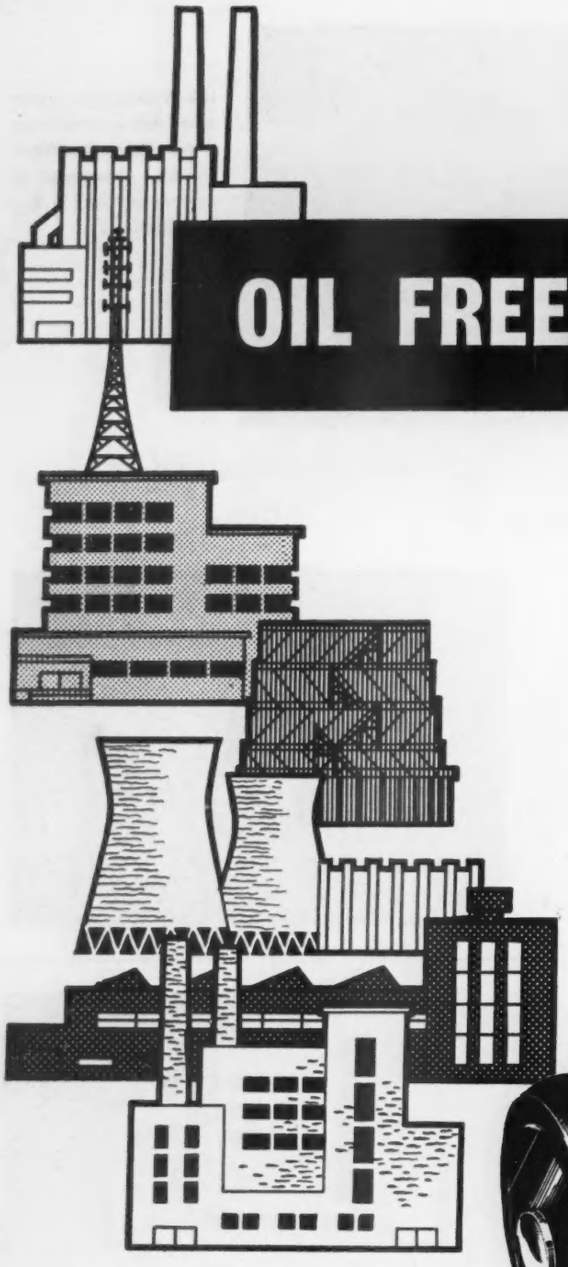

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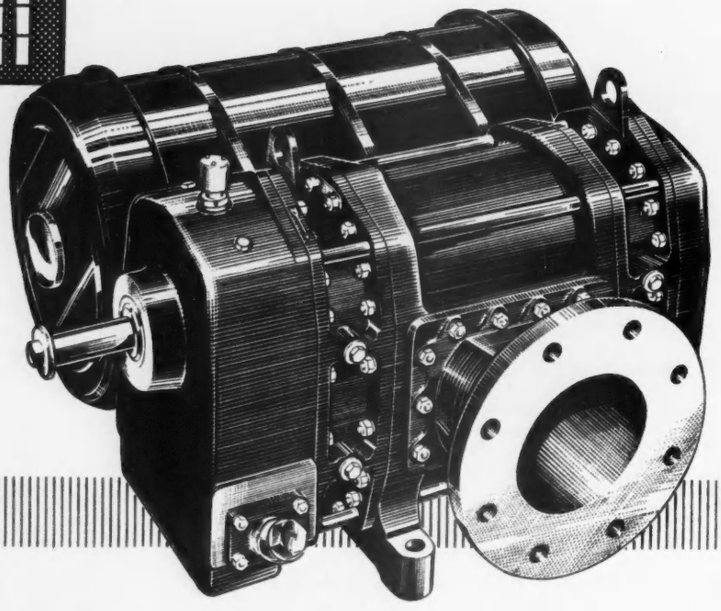

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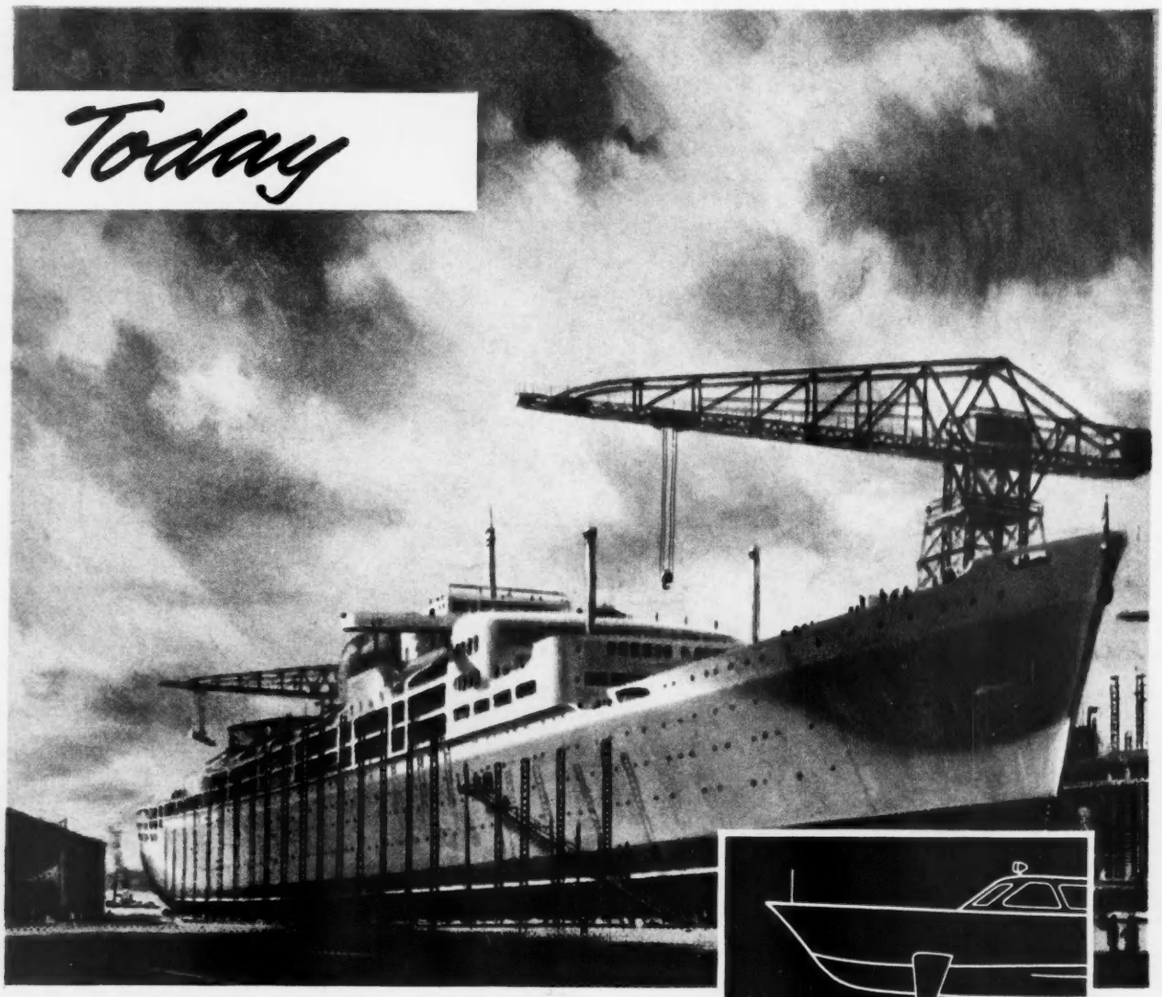

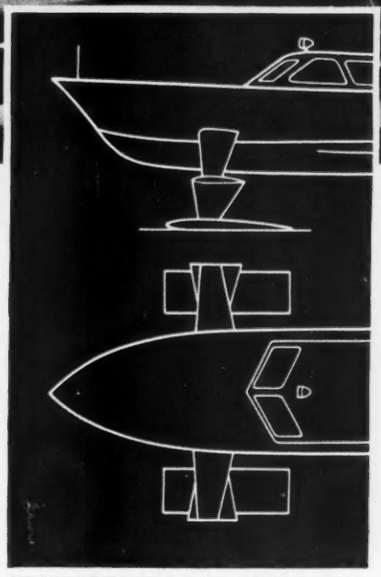

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